:ETALLURGICAL
:MINING MACHINERY.

Catalogue No. 5.

UNION IRON WORKS

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H.S.CROCKER CO. S.F.

UNION IRON WORKS,

SAN FRANCISCO, CAL.

BUILDERS OF

MINING MACHINERY

for the Reduction of Gold, Silver, Lead and Copper Ores.

GOLD AND SILVER MILLS,

Wet or Dry Crushing, Roasting, Concentrating, Leaching, Lixiviating,
Stamps, Amalgam Pans, Crushers, Settlers, Tanks,
Crushing Rolls, Jigs, Trommels, Screens.

Roasting Furnaces, Cupelling Furnaces,

Drying Floors, Shelf Dryers, Rotary Dryers.

Retorts, Bullion Moulds, Ingot Moulds, Copper Plates Electro-Silver-Plated for Gold Saving, Conveyors and Elevators.

WATER-JACKET BLAST FURNACES,

Blast Pipe, Slag Cars, Slag Pots.

HOISTING WORKS, PUMPING, CONCENTRATING AND SMELTING PLANTS.

MACHINERY FOR TRANSMISSION OF POWER BY WIRE ROPE.

Wheelock, Corliss, Scott & O'Neil

AND SLIDE-VALVE ENGINES.

BOILERS, AIR COMPRESSORS, ROCK DRILLS,

ETC., ETC.

UNION IRON WORKS,

SAN FRANCISCO, CAL.

Scene of Marshall's Gold Discovery,

AT SUTTER'S SAWMILL,

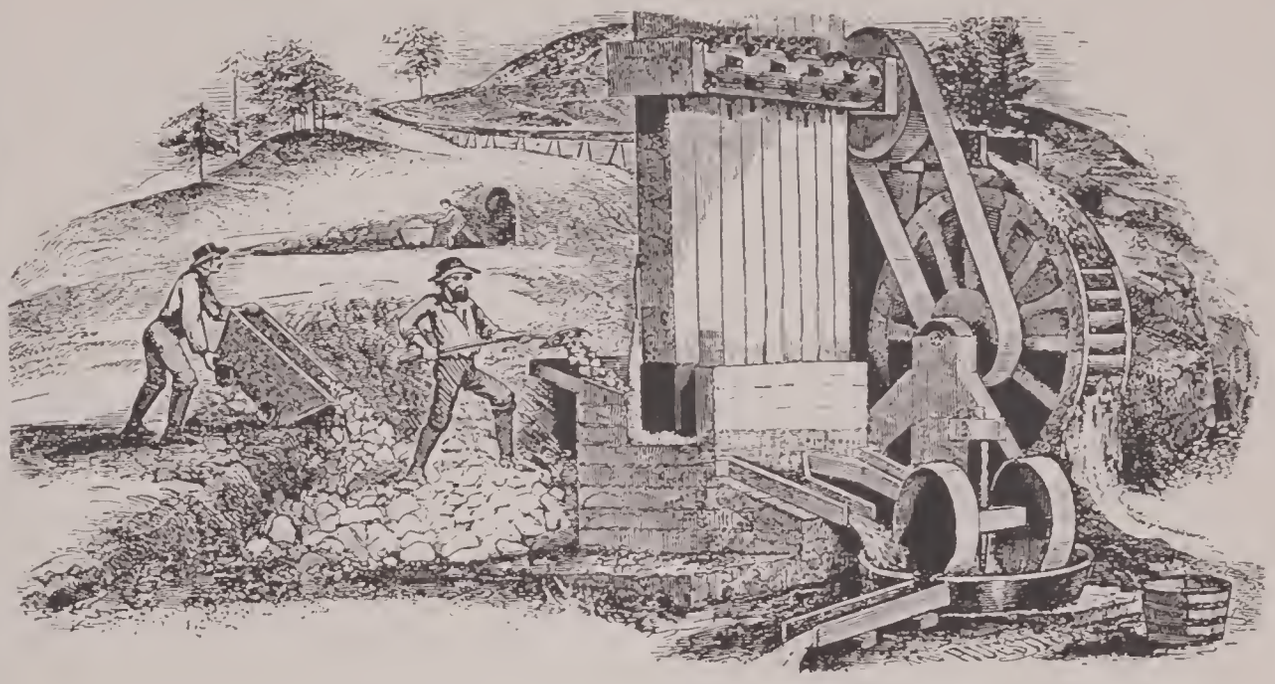
EL DORADO COUNTY, CALIFORNIA,

JANUARY 19, 1848.

A Stamp Mill in the Sixteenth Century.

The illustration above is introduced here simply as a curiosity; it shows a reproduction of a wood cut of a Saxon stamp mill, taken from the well known work of Georgius Agricola von Bergwerk, published in 1557. It gives a very good idea of the construction of a stamp mill three and a half centuries ago.

It was driven by a water wheel, and had a wooden barrel from which wooden cams projected. The stamp stems were made of wood, the shoes of stone and the ore was stamped on a granite boulder dry or wet, the latter method having been introduced as an improvement on the former one, about the beginning of the sixteenth century. Although the machine is very crude, made entirely of wood bound together with rawhide and wooden pins, the same general principles are still used in all modern mills.



First Stamp Mill in California.

The Gold Mill illustrated above was considered in the "days of '49" one of the most modern and improved mills for the treatment of gold ores, although, after the lapse of over three centuries, there was but little improvement over the one shown on the opposite page.

The bed for the mortar-block consisted of layers of timbers, crossing at right angles, tamped with sand and flooded with water. On this was placed the frame of the battery, and between the posts was fitted the mortar-block, not standing on end and deep in the ground as now, but lying on the ground, as did all the timbers under it.

On the block was placed a low iron mortar, the sides of which were built up of plank and carefully secured with rods, bolts and screws. In the mortar worked nine stamps, each consisting of an iron head, 18 inches long by 6 inches square, without any shoes, and a timber 10 feet long by 7 inches square. Through this timber was a slot wide enough to let the pegs play freely, to lift and drop it, the stamp being kept in place by suitable guides, top and bottom.

The engraving perhaps gives a better idea of the mill than can be conveyed by any lengthy description.

On the following pages will be found illustrations and comprehensive descriptions of the modern gold mill, with its accessories, which show the wonderful development and improvement made during the last half century in this class of machinery.

H. S. CROCKER CO.,
STATIONERS AND PRINTERS,
SAN FRANCISCO, CAL.

H. T. SCOTT,
President and Treasurer.

IRVING M. SCOTT,
Vice-Pres't and Gen'l Manager.

J. O'B. GUNN,
Secretary.

G. W. DICKIE,
Manager.

WILLIS G. DODD,
Mining Engineer.

CATALOGUE No. 5,

UNION IRON WORKS.

GOLD MILLING,

METALLURGICAL

AND

MINING MACHINERY.

Office, - - - - - - - - - 222 Market Street.
Main Works, - - - - - - - - - - Potrero.
City Works, - - - - - 225 and 227 First Street.

CABLE ADDRESS, "UNION."

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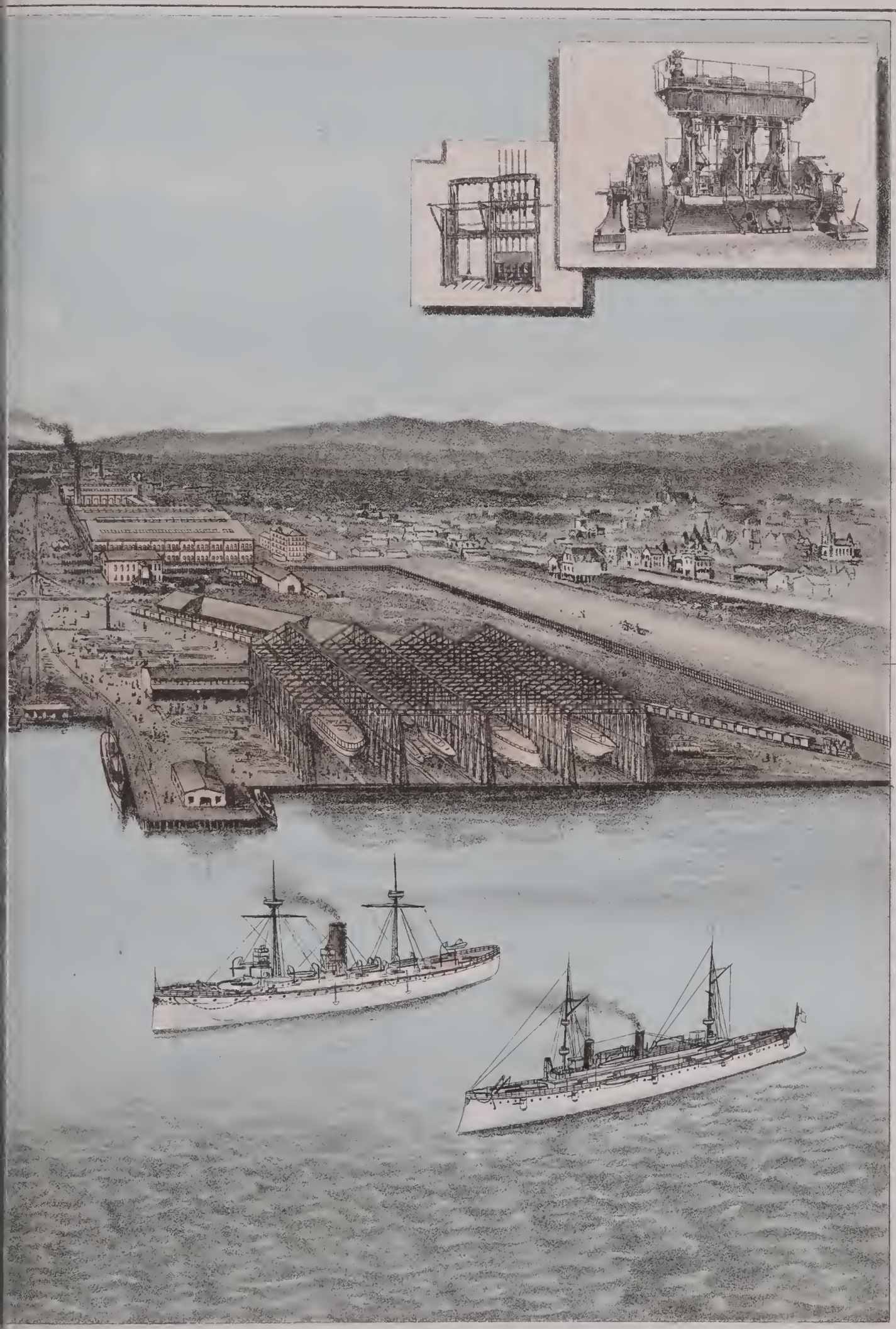
GENERAL VIEW UNION IRO



CHARLESTON

OLYMPIA.

KS, SAN FRANCISCO, CAL.

INDEX.

INTRODUCTION.

In presenting this, our latest revised and enlarged Illustrated Metallurgical and Mining Machinery Catalogue, it is our intention to place before our friends, and mining public in general, a book that will be generally useful, the perusal of which will show the progress that has been made in this branch the last few years, and also shows that we have made it a point to keep pace with the various improvements that have been made from time to time in this class of machinery, as a result of which we are now in possession of the latest patterns, and our tools are of the latest and most modern design, thus facilitating rapidity and accuracy of work.

The Union Iron Works have been established on the Pacific Coast since the year 1849. Our progress and prosperity may be noted by the steady growth from a small shop, until to-day it is the largest and best-equipped plant of its kind in the United States, and our engineering ability the best the country affords.

Having branched out into the Ship Building Industry, our shipyards and docks are as fine and as well equipped as those to be found anywhere.

The brick buildings cover an area of 250,000 square feet, the ground floor being six acres.

Shops, shipyards, dry docks and slips include an area of twenty-five acres.

Fitting, erecting, foundry, boiler shop and permanent scaffolding over the shipways are all fitted with overhead traveling cranes from eight to fifty tons capacity.

The main buildings have iron roofs, brick walls, lighted from sides and roof, and supplied with electric and hydraulic systems for hoisting, shearing, riveting, flanging and stamping.

In the shipyard is to be found one of the largest hydraulic dry docks in the world, and large 100-ton shears for placing machinery in vessels.

The works are conveniently situated on the Bay of San Francisco, and the tracks of the Southern Pacific Railroad enter its yards; thus being so advantageously located, we are enabled to obtain the best of rates and to ship by rail or water to all parts of the globe.

As our manufacture of mining and metallurgical machinery dates back to the earliest mining in California, our experience as a natural result has been extensive, but it is not limited to the State of California alone; for our mining and milling machinery can be found in all the mining camps and districts of America, Alaska, Mexico, Central and South America, Australia and Africa; thus, from our experience and facilities, we are in a position to produce the finest class of work with the greatest precision and dispatch.

These facts are presented to the public so that they will be assured of the competency of our extensive works to cope and compete with all other builders of mining and milling machinery.

Our steady growth and splendid success in the past is the best reward and testimonial that we can offer for our work and reliability.

Information not contained in this catalogue, which from experience we may possess, we will with pleasure furnish upon application.

We herewith respectfully solicit the patronage of those requiring machinery of which we are builders.

Respectfully,

UNION IRON WORKS.

SAN FRANCISCO, CAL.

General Remarks on Machinery.

It is a well-known fact among mining men that the Union Iron Works have always maintained a very high standard of work, and have contributed more perhaps than any other one concern to the many improvements in mining and reduction machinery for the systematic mining, milling, smelting and concentration of ores, to which the wonderful mineral development of the country and abroad is so highly indebted.

No class of machinery should receive so much care in construction as that intended for mining purposes. It goes into remote and inaccessible localities where repairs are always made at a great disadvantage, and with serious loss of both time and money. The purchaser of mining machinery cannot afford to ignore the fact that the *best* work that can be done is the *cheapest*, even at an enhanced cost.

The excessive competition to which most of the work is now subjected is not calculated to produce the highest standard of excellence. Parties who have had the most experience in the purchase of this class of machinery recognize the fact that very low prices invariably mean cheap and inferior work.

Another point generally lost sight of is the quality of material entering into its construction. None but those familiar with the business can appreciate the difference in the intrinsic value of work on this score, and the difficulty of guarding against this manner of cheapening it where there is a disposition to do so on the part of the manufacturer.

Then there is a question of proper proportion for strength without undue weight, and the substitution of wrought iron and steel for cast iron, which can be done in many cases to the great advantage of the buyer. Where freight forms so large a part of the cost, as it generally does in mining machinery, this is a matter of the first importance.

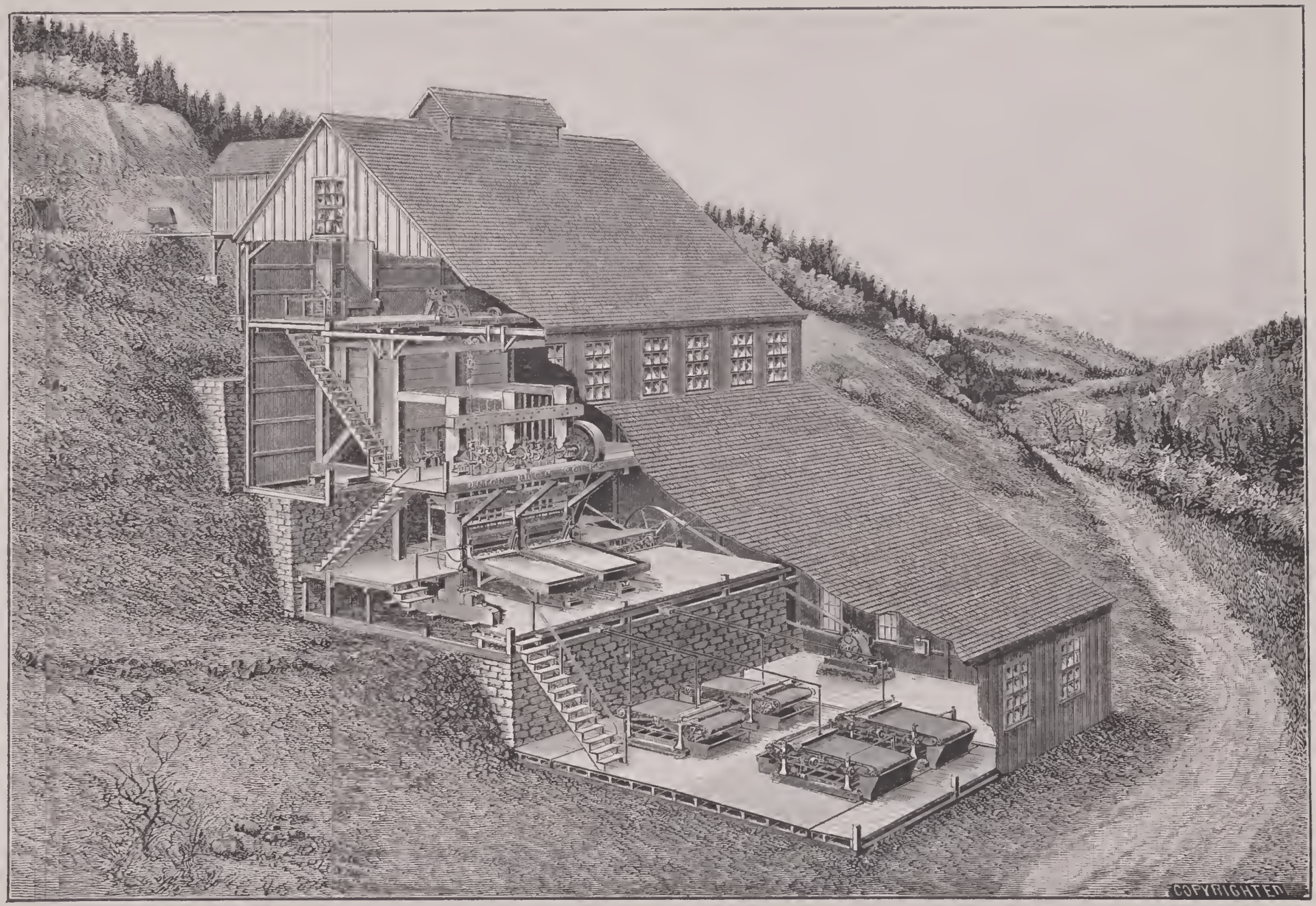
The manifestly safe way is to patronize such establishments as are disposed to consult the interests of the purchaser in all that relates to improved design and construction, and who care quite as much for their reputation for honest and conscientious work as for the matter of profit.

Purchasing parties can have every assurance of honorable dealing and the benefit of our *long experience* and intimate knowledge of the business in all its branches.

Respectfully,

UNION IRON WORKS.

San Francisco, Cal.



Ten-stamp Gold Mill.

(DRIVEN BY ELECTRICITY)

Gold Milling.

The Gold Mill as illustrated on the opposite page is used for the reduction of "free" milling gold ores. Mineralogically, these ores are characterized by a quartz gangue or matrix, carrying native gold, with which are generally associated auriferous sulphurets. Iron pyrite is usually the predominating auriferous sulphuret. It is often accompanied by auriferous arsenical pyrites, chalcopyrite, zinc-blende, galena and less frequently by some of the telluride and other rare minerals.

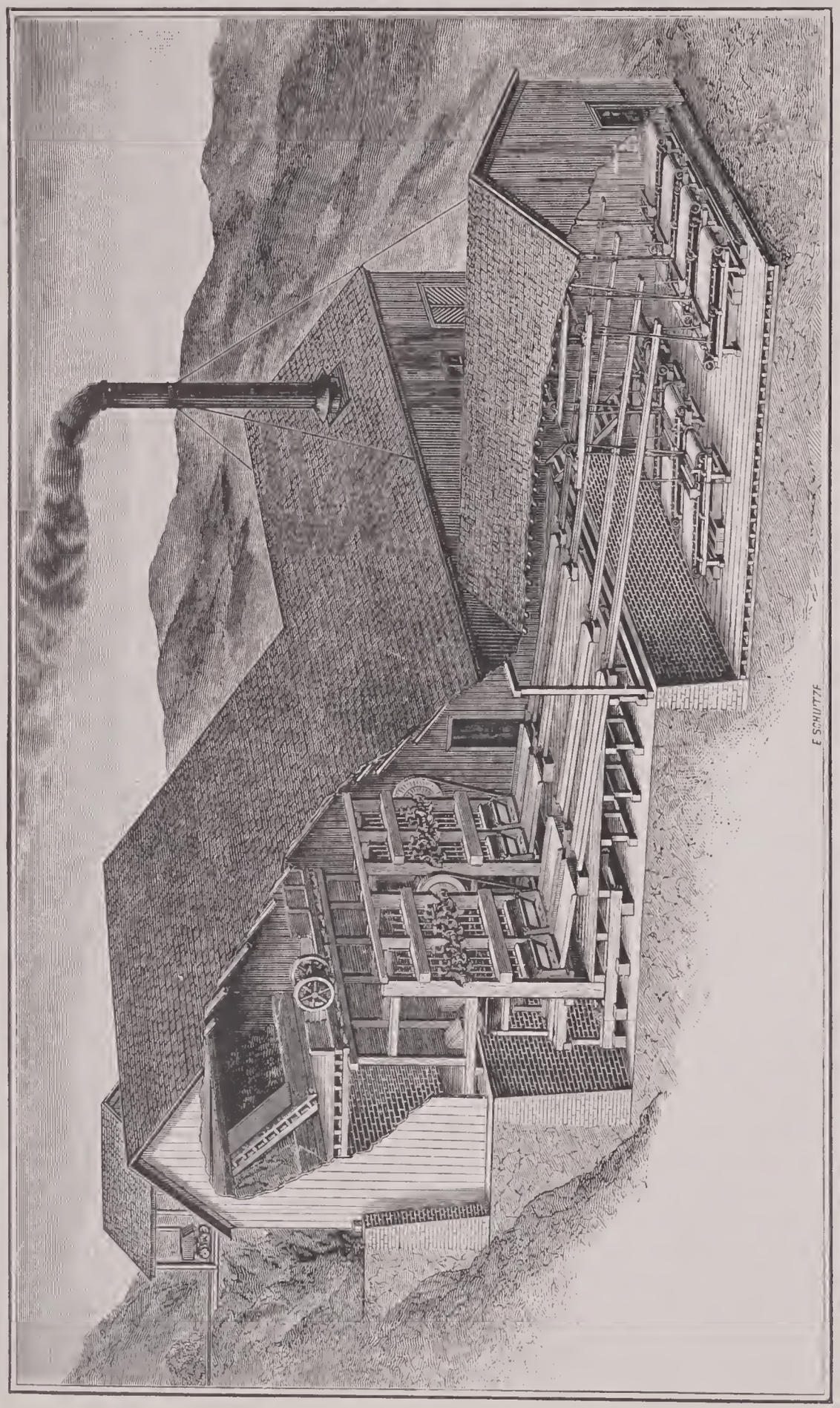
OUTLINE OF PROCESS.

The ore is dumped on an inclined "grizzly," as shown. The finer ore passes through the spaces between the bars and falls directly into the ore bin. The coarser ore (too large to pass through the grizzly) is screened off by gravity and falls on the floor close to the rock breakers. By these it is crushed and falls into the ore bins. From the ore bins the ore passes through gates into the "automatic feeders" (see illustration) which supply it to the batteries. Quicksilver is fed at intervals to the mortars, and coming in contact with the native or "free" gold in the pulverized ore (or pulp) forms amalgam, which is caught partly by the copper plates in the battery, and partly upon the silver plated copper amalgamating plates, placed in front of the screens, through which all the pulp must pass.

The amalgam is "cleaned up" periodically and retorted. Retorting consists in the sublimation of the quicksilver, the vapors of which are condensed in water and the quicksilver collected. The residual gold is in a porous state. It is melted with fluxes in crucibles and cast in ingots.

SULPHURETS—The pulp from which the free gold has been extracted by amalgamation is passed over some concentrating device of which there are many in use. These "Concentrators" effect a separation of the auriferous sulphurets from the worthless gangue, which is run out as tailings. In California the sulphurets are treated generally by the Plattner Chlorination Process (see pages 92 and 93), but the cyanide process (see Catalogue No. 9) is used to some extent, and especially upon very fine sulphurets. When the treatment of sulphurets is inconvenient at the mine they are generally sold to smelting works.

The gold ores of California carry on an average two per cent of sulphurets. The concentrated sulphurets assay on an average from $60 to $90 per ton in gold, with from a trace to several dollars in silver.



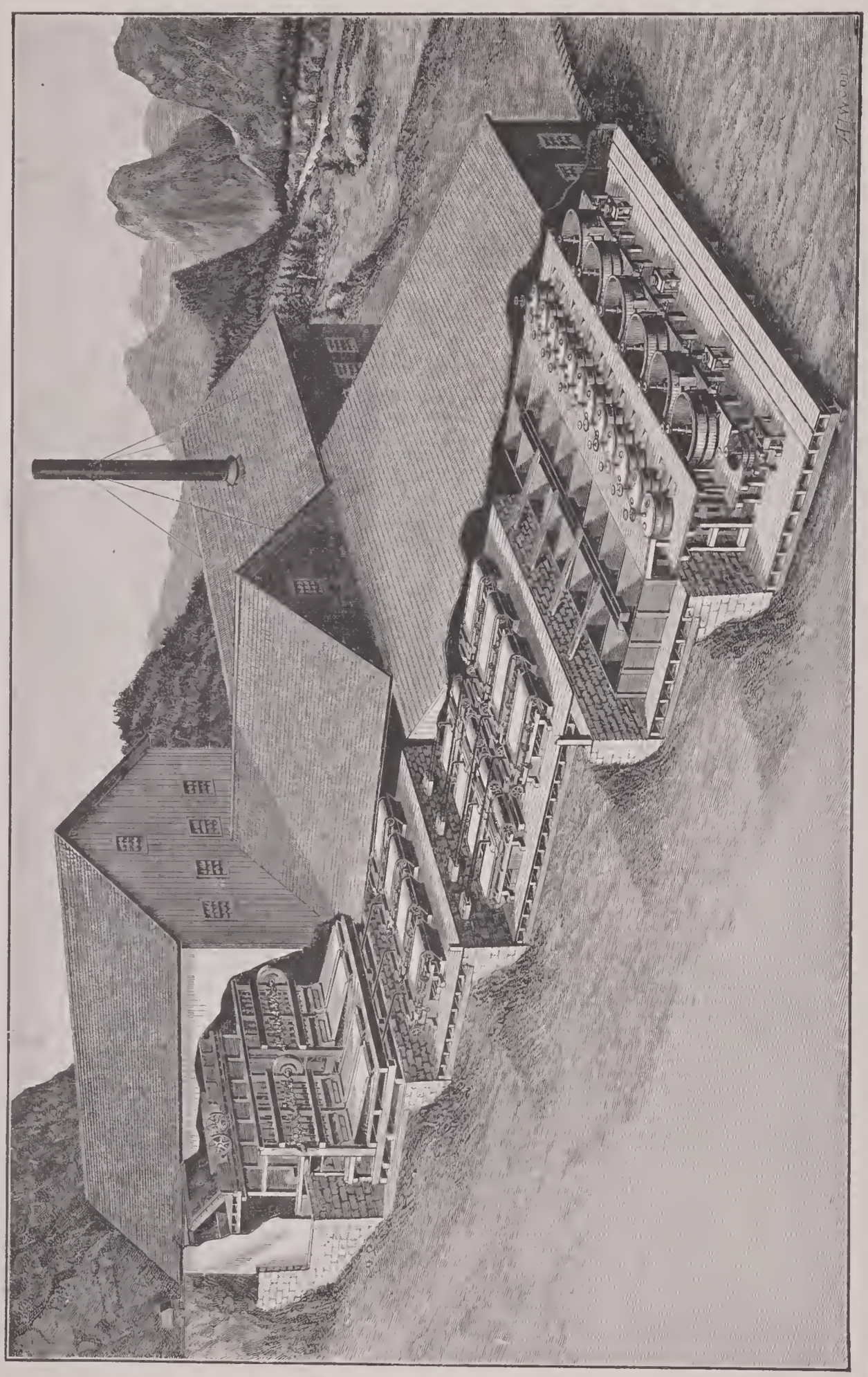
Twenty-stamp Gold Mill with Concentrators.
(STEAM POWER.)

General Specifications for Gold Mills.

Size of Mill.....Number of Stamps..	**10**	**20**	**30**	**40**	**60**
Weight of Stamps	850	850	850	850	850
Capacity in 24 hours, tons	30	60	90	120	180
Number of Grizzlies, 4′ x 10′	1	1	1	2	3
Number of Union Iron Works Crushers	1	1	1	2	2
Size of Crushers	8 x 12	8 x 12	8 x 12	8 x 12	8 x 12
Number of Ore Bin Gates	2	4	6	8	12
Overhead Crab and Chain Block	1	1	1	2	2
Number of Union Automatic Ore Feeders	2	4	6	8	12
Number of Copper Plates	2	4	6	8	12
Size of Copper Plates	4′ x 12′	4′ x 12′	4′ x 12′	4′ x 12′	4′ x 12′
Number of Union Ore Concentrators	4	8	12	16	24
Four-foot Clean-up Pan	1	1	1	1	2
Gold Retort and Melting Furnace	1	1	2	2	4
Size of Engine for driving Mill	10 x 20	12 x 24	14 x 30	16 x 42	20 x 42
Number of Boilers	1	1	2	2	2
Size of Boilers	42″x 14′	48″x 16′	42″x 14′	54″x 16′	60″x 16′
Size of Cameron Steam Feed Pump	No. 0	No. 1	No. 2	No. 3	No. 4
Size of Llewellyn Heater	No. 3	No. 4	No. 5	No. 6	No. 7
Horse-power required to drive Mill	30	46	70	100	150
Water required in gallons per hour	1,600	3,200	4,800	6,400	9,600
Total approximate weight in tons	30	55	85	113	163

All necessary shafting, pulleys, boxes and tighteners according to our plans.
All piping, valves and fittings for steam and water connections.
All belting and lace leather complete.
All bolts and washers for frame work and machinery.

In specifications we are always ready and willing to suit the ideas of engineers and millmen. Plans, specifications and estimates furnished upon application.



Twenty-stamp Mill, Combination Process, with Union Improved Concentrators.

Combination Process.

The illustration on the opposite page gives an interior view of a Twenty-stamp Combination Mill equipped with Union Improved Concentrators.

The "Combination Process" is the method of treating gold and silver bearing ores by the application of the concentration and amalgamation processes combined, and is especially adopted to ores that are not "free milling."

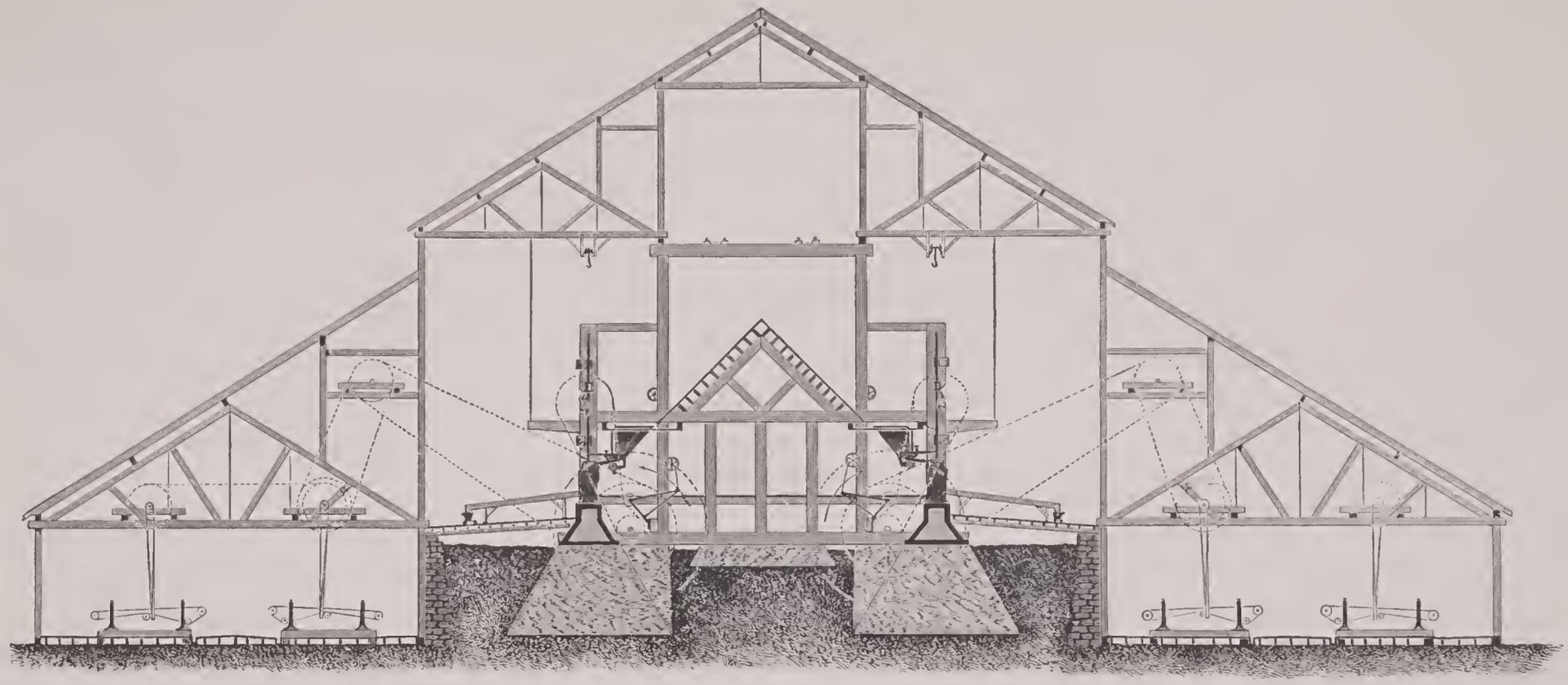
It is not an experimental nor new process, but simply a combination of well-known and successful methods in daily operation throughout the mining sections of the country.

The mill, which we illustrate herewith, is designed to treat refractory ores carrying gold and silver associated with the baser metals, such as iron and copper pyrites, lead, zinc, antimony, etc.

The ore is first passed through the rock breaker or crusher into the ore bins, from whence it passes automatically into the self-feeders, which deliver it, as required, into the mortars of the battery. Here it is crushed wet, and discharged through the battery screens upon silver-plated copper plates, which extract the free gold contained in the ore. From these plates it passes on to the first set of Union Improved Concentrators, where the heavier base metals are eliminated. The tailings from these machines then pass on to the second set of Union Improved Concentrators, where the final concentration takes place, eliminating the zinc, antimony, etc. The tailings from this last set of machines, containing the sulphides, chlorides and fine gold which cannot be concentrated, pass into the settling tanks, where, after the surplus water is drawn from the pulp, it is shoveled into the pans, amalgamated, discharged into the settlers, and the amalgam strained, retorted and melted in the usual manner.

The concentrates obtained can be disposed of as may be best suited to the commercial conditions governing each particular case.

This process is being adopted by many of the largest mines; and, for such ores as we have described, the "Combination Process" is not only the cheapest but the most practical method of reduction that can be employed under any and all conditions.



Cross Section of a Modern Wet-crushing Gold Mill.

The illustration above is a cross section of a modern Wet-crushing Gold Mill of large capacity, 100 stamps or more.

It shows the general design of the building, having the ore bin built in the center with the batteries on both sides, placed back to back, the automatic ore feeders of the hanging type and the silver-plated copper apron plates, arranged so they can be run forward out of the way when repairs are necessary. It further shows the arrangement for driving the different machines and the concentrator room on each side of the battery.

Plans, specifications and estimates cheerfully furnished for mills of any capacity.

The Grizzly.

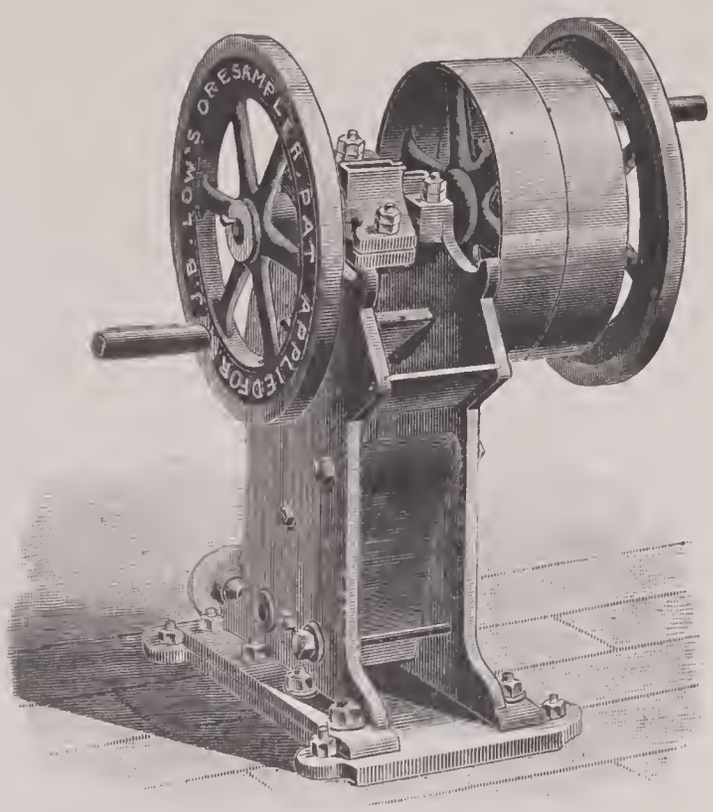
The grizzly illustrated below is made of special bar iron set on edge and bound together with wrought-iron rods and mesh thimbles. The iron used is rolled thinner on the lower edge, so that no rock can stick between the bars.

It is built into the woodwork above the bins at an angle of 35° to 40°, and all the ores brought to the mill are dumped upon it, the finer portion passing through into the bin, and the coarse passing by gravity to the rock breaker, and after crushing drops into the ore bin.

We manufacture them of any required mesh and size.

PRICE LIST, WEIGHTS, SIZES, ETC.

Width in feet.	Length in feet.	Mesh in inches.	Bars.	Weight in pounds.	Price.
3	6	2	⅝ x 3	600	$ 35.00
3	8	2	⅝ x 3	800	42.00
3	10	2	⅝ x 3	1,000	48.00
4	8	2	⅝ x 3½	1,200	55.00
4	10	2	⅝ x 3½	1,500	66.00
4	12	2	⅝ x 3½	1,800	75.00
5	10	2	¾ x 3½	2,400	92.00
5	12	2	¾ x 3½	2,900	104.00

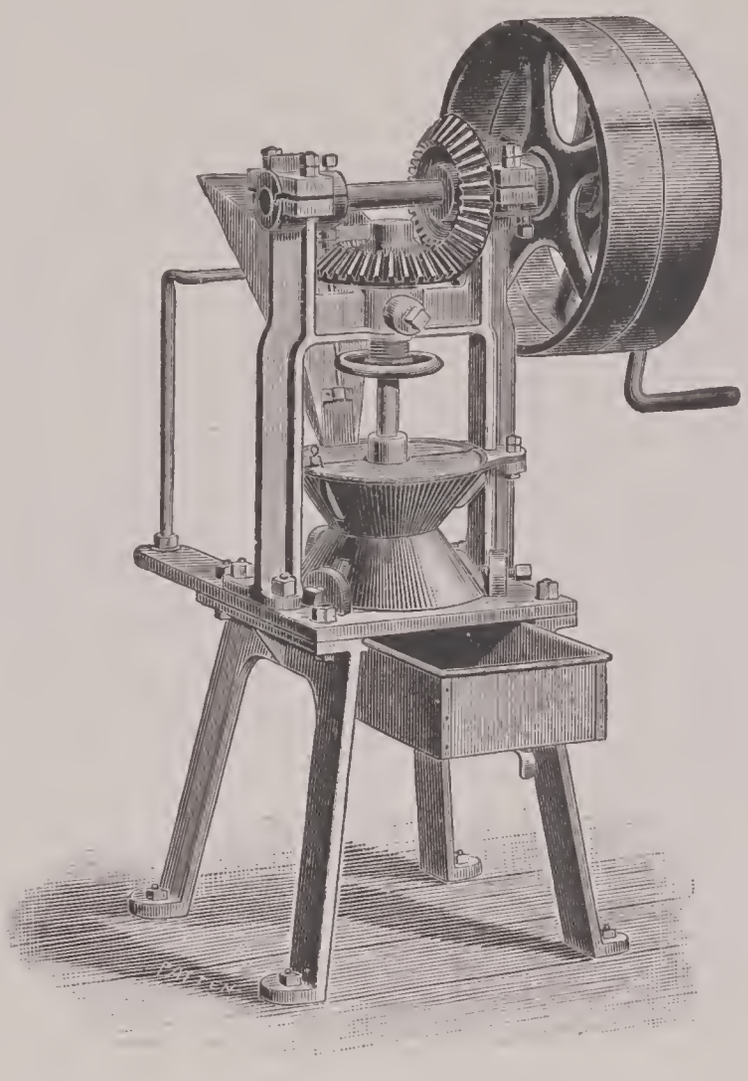


Low's Ore Sample Crusher.

The above illustration shows Low's Ore Sample Crusher. The machine is so designed that it can be opened and perfectly cleaned at a moment's notice. There are two breaking jaws, one movable and one stationary. The latter is hinged on top and held rigid on the bottom by a bolt slipped through both sides of frame and directly in front of jaw. After each sample is ground this bolt is removed and the jaw swung up on the hinge, exposing to view the whole inside of the machine and allowing access to every part where dust might have lodged, thus destroying the accuracy of the following assay. As so much depends on machines of this kind, we have used every effort to make this as perfect as ingenuity and mechanical skill could devise.

It can be operated both by hand or belt. It is a useful machine in any mill or smelter, and particularly in custom works and laboratories. The ore is here crushed preparatory for the sample grinder illustrated on opposite page. The wearing parts can easily be replaced when worn out.

Weight, 400 pounds. Price, $80.00.



Low's Ore Sample Grinder.

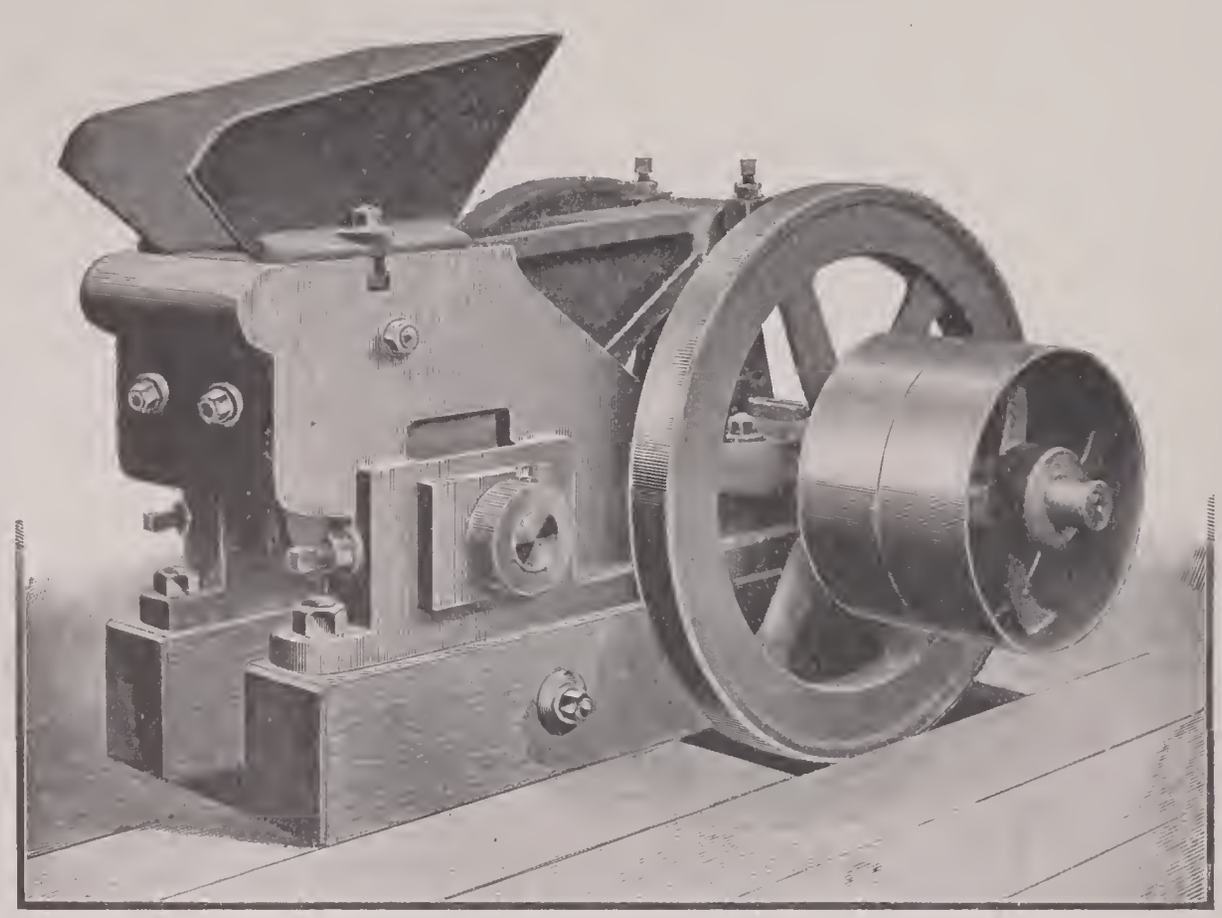
The above illustration shows Low's Ore Sample Grinder. It receives the material from the sample crusher and grinds it to a fine powder ready for the assayer.

The machine is designed so it can be opened and perfectly cleaned at a moment's notice. The outside and inside cones or grinders are so constructed that access is easily had to them. The outer cone is held in place by four set screws, as shown in illustration. When it is desired to clean the machine these screws are loosened and the cone slipped up, exposing the inside of the machine and allowing free access for cleaning. It will be further noticed that the upper cone forming a hopper is the same as the bottom, and can be reversed, giving a new outer grinding shell when the latter is worn out. As so much depends on machines of this kind, we have used every effort to make this as perfect as ingenuity and mechanical skill could devise. It can be operated both by hand or belt.

It is a useful machine in any mill or smelter, and particularly in custom works or laboratories.

The wearing parts can easily be replaced when worn out.

Weight, 250 pounds. Price, $80.00.



Improved Dodge Crusher.

The Dodge Crusher shown in the illustration above should be employed when fine crushing is desired. It is particularly adapted for crushing after the Union or Blake, to produce a fine and even product.

In this crusher the movement is greatest at the top of the jaw, the lower part remaining nearly stationary, and the product leaving the machine must be of nearly uniform size,—determined by the distance the jaws are set apart.

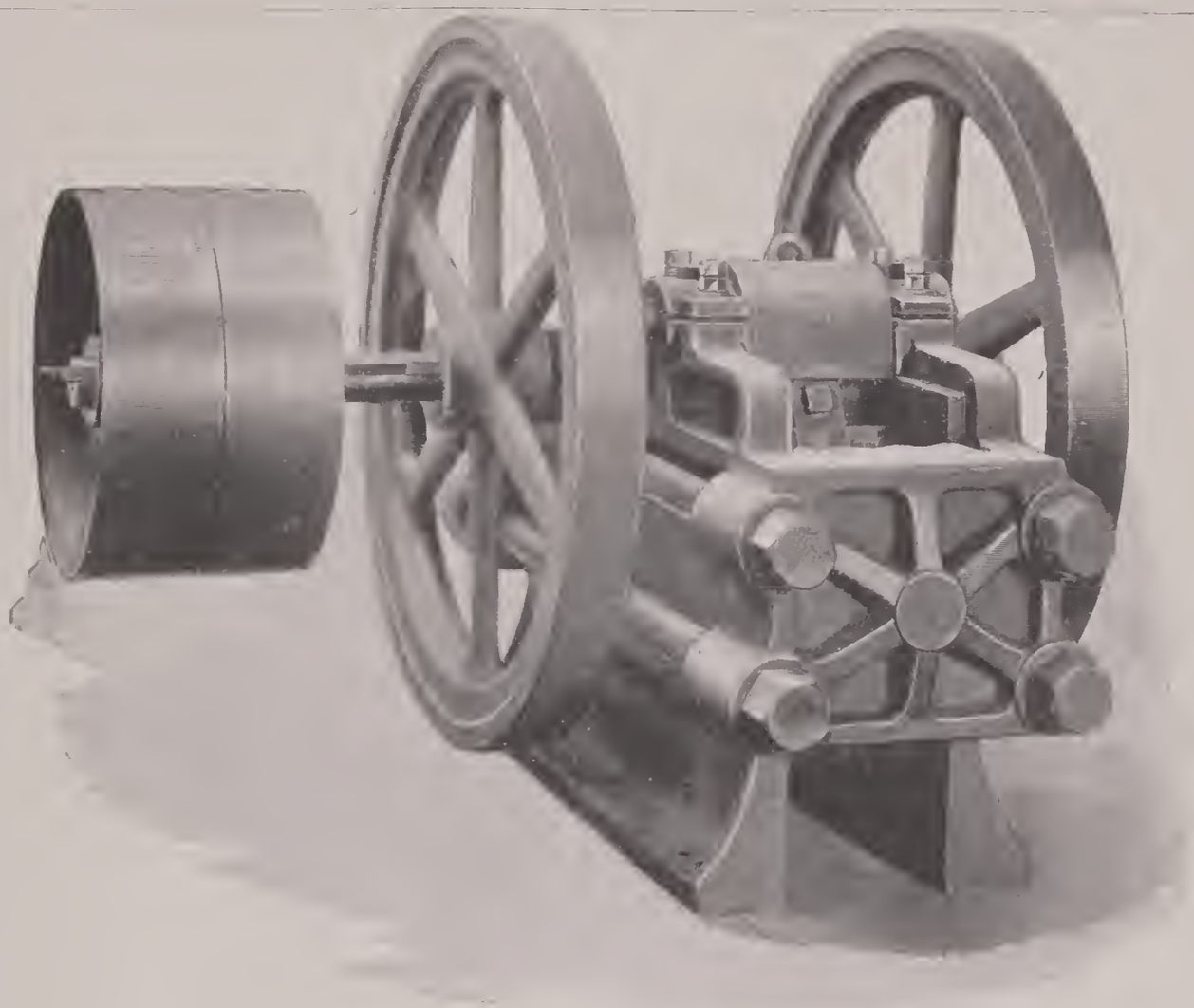
The jaw shaft rests in movable boxes, and the opening is varied by the position of these being fixed by packing plates on either side and tightening up the screws.

The jaws and cheeks are provided with removable steel dies and plates, which, when worn, may be easily replaced.

PRICE LIST, SIZES, WEIGHTS, ETC.

Size of opening inches.	*Capacity in tons per hour.	Extreme dimensions.			Driving Pulley tight and loose.		Proper speed. Revolutions.	Horse Power.	Weight of heaviest piece.	Total weight.	Price.
		Length. ft. – in.	Breadth. ft. – in.	Depth. ft. – in.	Diam. ft. – in.	Face. inches.					
4 x 4	½ to 1	2 – 4	2 – 1	1 – 6	0 – 10	3½	400	1	200	600	$125.00
6 x 6	1 to 2	3 – 0	3 – 0	2 – 0	1 – 0	5	350	3	360	1,200	175.00
7 x 8	3 to 4	3 – 9	3 – 7	3 – 0	1 – 4	6	300	5	912	2,200	330.00
8 x 12	4 to 6	4 – 6	5 – 3	4 – 0	2 – 0	8	250	7	2,100	4,600	550.00

*The capacity of the machine is determined by the fineness to which the material is crushed.



The Blake Ore Crusher.

The illustration above shows the Blake Ore Crusher as manufactured by us. Its action is identical with that of the Original Blake (i. e., a swinging jaw, hung at the top, having its greatest movement at the bottom, and receiving its motion through toggles and an eccentric shaft), but with improvements in construction, suggested by years of experience and careful observation, producing a machine stronger and more durable, with the wearing parts easier of access and adjustment. This has been for years the Standard Crusher, and is used in many of the principal mines for breaking ore to convenient size for feeding to stamps.

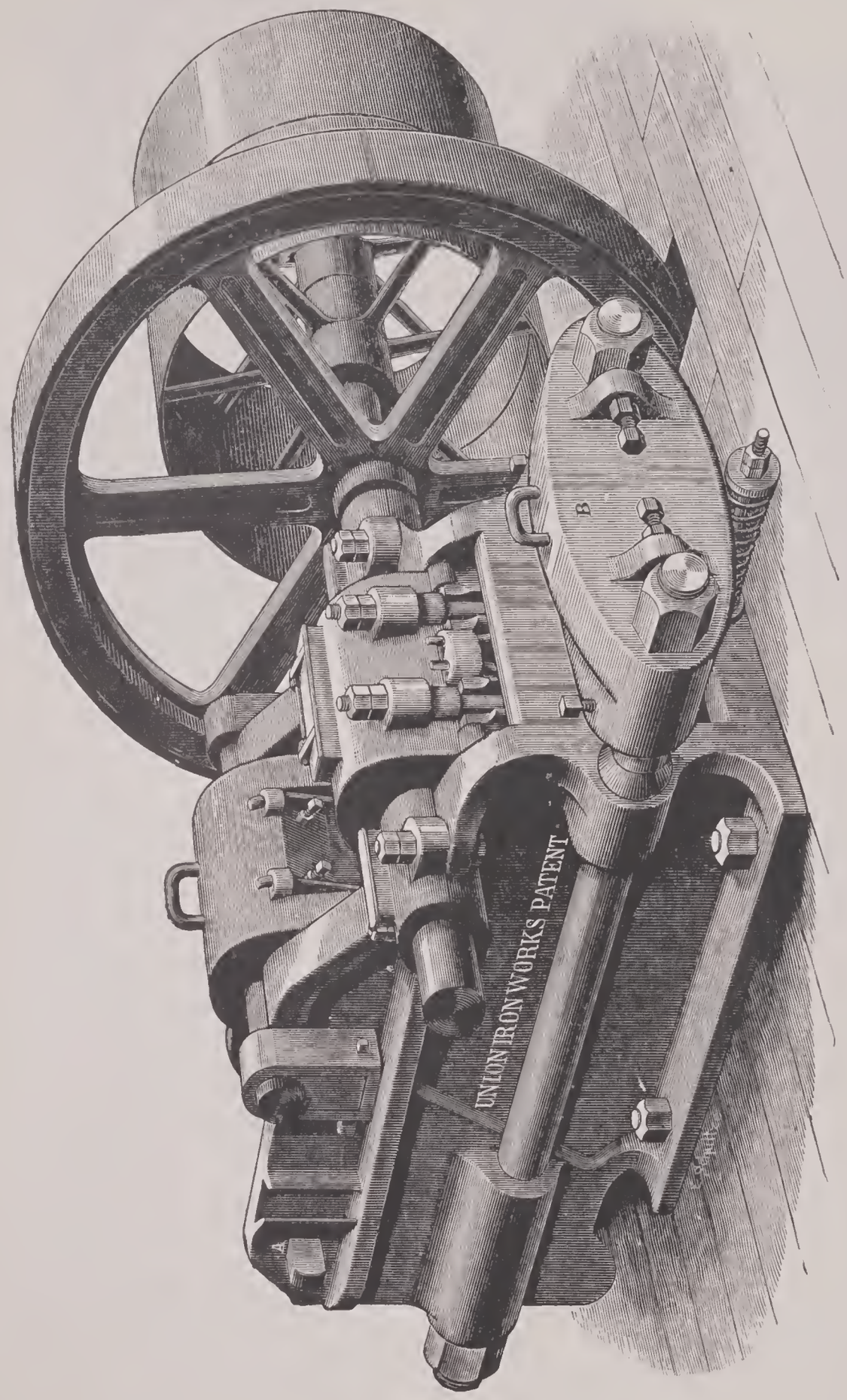
Heavy wrought-iron bolts take the strain while crushing, giving more strength, and dispensing with unnecessary weight.

Ore can be crushed to any size by regulating the opening between the jaws. This is accomplished by screwing up the nuts on the wedge bolts.

The shoes, dies and cheek plates are of steel, and can be easily replaced and adjusted.

PRICE LIST, SIZES, WEIGHTS, ETC.

Size of opening, inches.	Capacity in tons per hour.	Driving Pulley tight and loose.		Proper speed. Revolutions.	Horse power required.	Weight of heaviest piece.	Total weight.	Price.
		Diameter.	Face.					
6 x 9	3 to 5	22	6½	300	5	600	4,300	$325.00
8 x 12	5 to 8	30	6½	250	8	1,600	5,600	500.00
10 x 16	9 to 15	30	10½	200	12	3,600	13,000	850.00



The Union Patent Rock Breaker.

The Union Patent Rock Breaker.

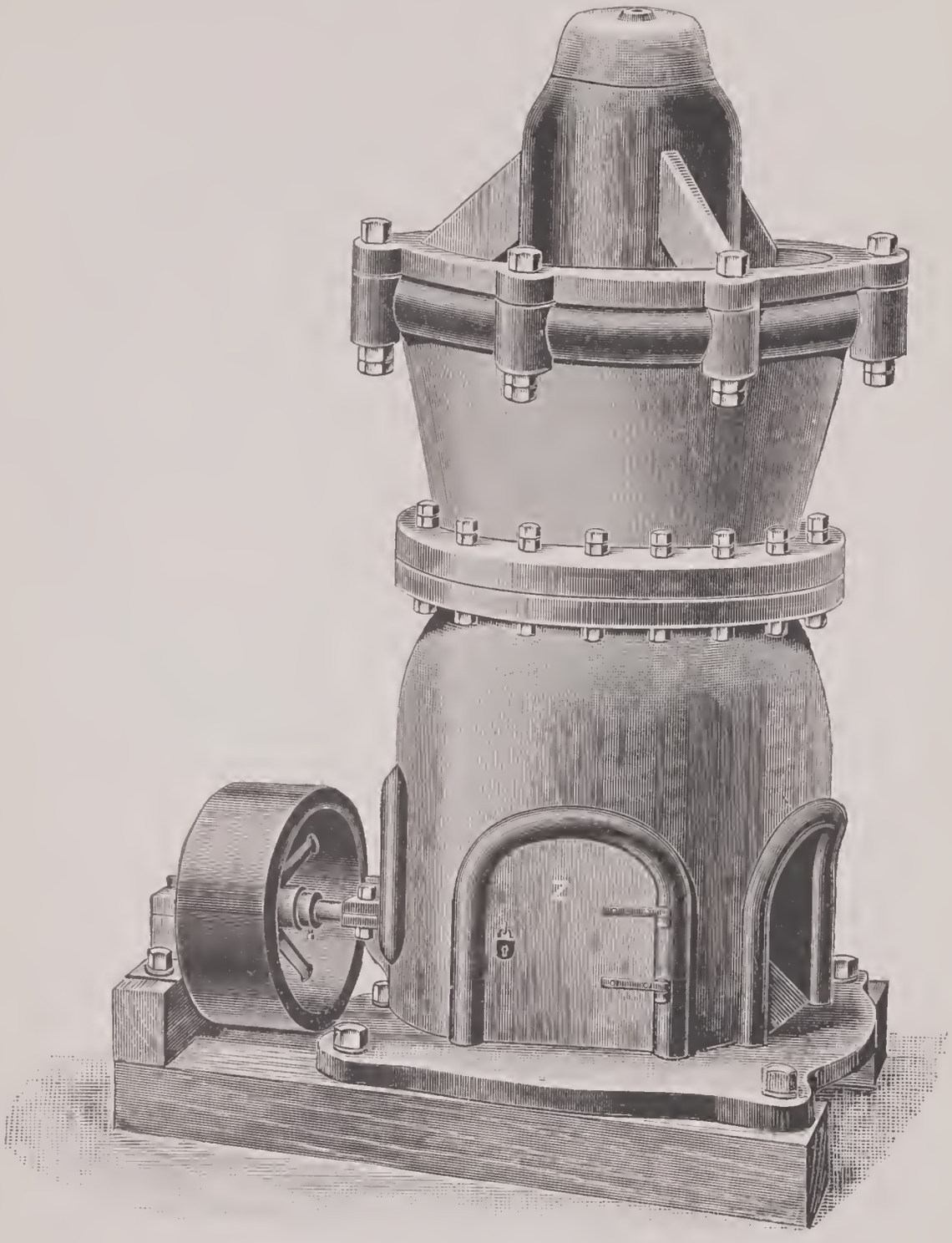
The action of the Union Patent Rock Breaker is the same in principle as the well-known "Blake," previously described, but certain differences in construction make it in many ways a more desirable machine.

The toggle bearings are so arranged that wedges and wedge-bolts are dispensed with, and the full range of adjustment for wear and different sized product is made by simply screwing up the nuts on the side bolts, instead of by the use of wedges and toggles of varying size, the toggles on this machine being made square and of uniform size, so that all four edges may be worn out.

The "Union" Breaker is built especially for heavy work, and parts subject to breakage by accident are easily replaced at small expense. The machine, for the same capacity, is somewhat lighter than the "Blake," and is generally preferred. When desired, we make them in 300 pound sections for mule-back transportation.

PRICE LIST, WEIGHTS, ETC.

Size of opening, inches.	Capacity in tons per hour.	Driving Pully tight and loose.		Proper speed. Revolutions.	Horse-power required.	Weight of heaviest piece.	Total weight.	Price.
		Diameter.	Face.					
6 x 9	3 to 5	22	6½	300	5	575	4,000	$350.00
8 x 12	5 to 8	30	6½	250	8	1,600	5,300	500.00
10 x 16	9 to 15	30	10½	200	12	3,600	12,500	850.00



The Union Gyratory Crusher.

The Union Gyratory Crusher.

The illustration on the opposite page shows the Union Gyratory Crusher. In all machines of this class, excepting the Union, the immense weight of the shaft and crushing head, together with the downward pressure or strain incident to crushing, falls upon a bottom step or bearing which is the place of greatest movement or gyration of the shaft. This results in largely increased friction; gives much trouble, because the bearings heat and wear; necessitates additional engine power for operating the crusher, and entails a loss of output by the required stopping of the machine to cool and repair the bearings.

Again, in all gyratory crushers heretofore used, when the shaft is adjusted, its line of bearing is changed by reason of altering the set angle of the shaft when adjusted, and it has to find or wear new line bearings after each adjustment, which produces undue friction, heating and wearing of bearings, and increased engine power is required for running the machine.

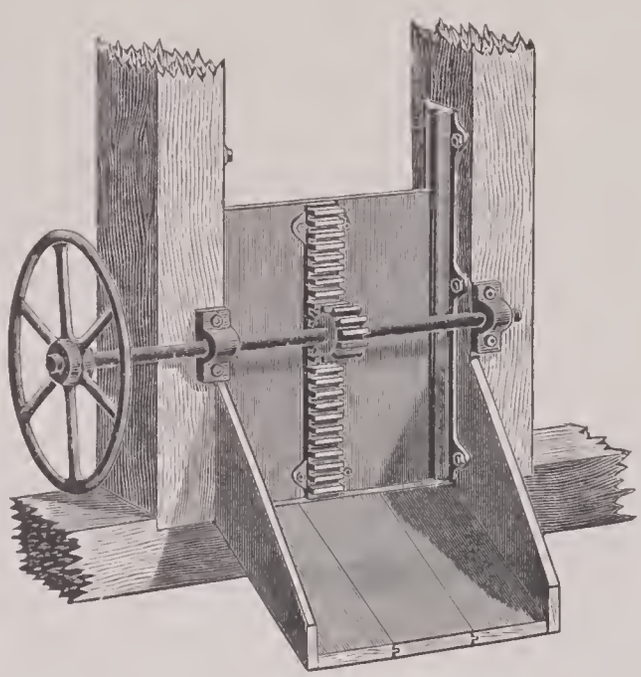
Heretofore, the operating mechanism of these machines has been and is now oiled through the pinion opening; and to do so, owing to danger of accidents, the machines must be stopped; and, further, no provision is made for removing the operating mechanism of the shaft from the machine in case of repairs or replacement of parts without dismantling the entire machine, and this all involves a loss of time and output.

The Union Crusher avoids all these disadvantages. All difficulties have been overcome by long, practical experience, and we claim we have a rock crusher that cannot be excelled by any known machine up to the present time.

For a full, detailed and comprehensive description, see our special pamphlet.

PRICE LIST, SIZES, WEIGHTS, ETC.

Size.	Size of openings in crusher.	Size of combined openings.	Capacity per hour in tons of 2,000 lbs., macadam or ballast. Size 2½ inches.	Dimensions of tight and loose Driving Pulley.		Revolutions of Driving Pulley.	Size of engine in horse-power for Crusher, elevator and screen.	Weight of crusher in lbs.	Price.
				Diam.	Face.				
1	5 x 12	5 x 36	4½ to 8½	20	4	500	5 to 6	5,500	$ 600.00
2	6 x 14	6 x 42	7 to 12	24	5	475	8 to 10	7,900	800.00
3	7 x 15	7 x 45	15 to 20	28	6	450	12 to 15	14,000	1,200.00
4	8 x 18	8 x 54	20 to 30	32	8	425	15 to 20	21,000	1,800.00
5	10 x 20	10 x 60	30 to 40	36	10	400	18 to 22	27,500	2,500.00
6	11 x 24	11 x 72	40 to 60	40	12	375	25 to 30	42,000	3,500.00
7	14½x 30	14½x 90	60 to 125	44	14	375	40 to 60	64,000	5,000.00
8	18 x 42	18 x126	100 to 150	48	16	375	60 to 75	91,000	6,500.00
9	20 x 44	20 x132	120 to 175	52	18	370	80 to 110	100,000	8,000.00



Ore Bin Gates.

The illustration above shows an Ore Bin Gate attached to an ore bin, its inclined bottom being an extension of the floor of the ore bin. The gate itself consists of a piece of boiler plate with a rack attached in the center, working in iron guides by the action of a pinion on the rack operated by a hand wheel at the side.

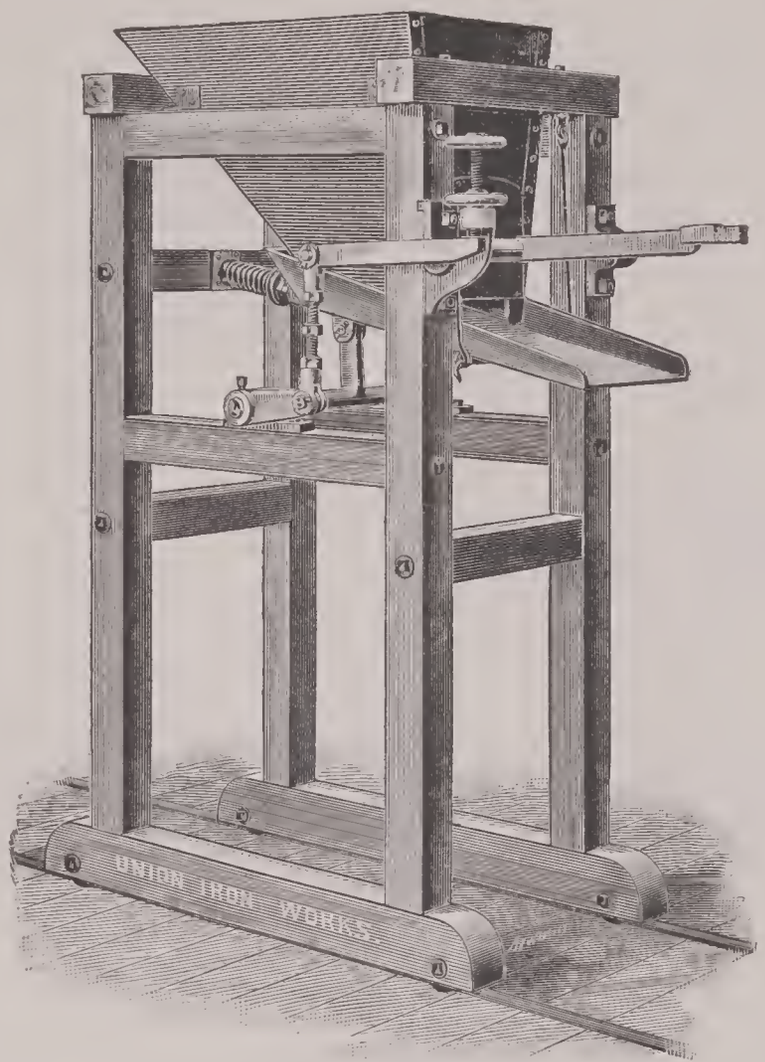
Ore Bin Gates in mills are used to supply automatic feeders and sometimes rock breakers.

The larger sizes are used in mines and on railroad tracks to load cars, and are indispensable in systematic mining and milling.

They are furnished complete with plate, rack, guides, shaft, boxes, hand wheel and all necessary lag screws, and are built of any required size.

PRICE LIST, WEIGHTS, SIZES, ETC.

Width in inches.	Height in inches.	Thickness in inches.	Length of shaft in inches.	Weight in pounds.	Price.
12	18	¼	33	160	$18.00
18	24	¼	39	180	20.00
18	26	¼	39	205	23.00
20	24	¼	41	194	22.00
24	28	¼	45	240	26.00
24	30	¼	45	315	30.00
24	42	¼	45	420	40.00
26	30	¼	47	290	32.00



"Junior" Tullock Ore Feeder.

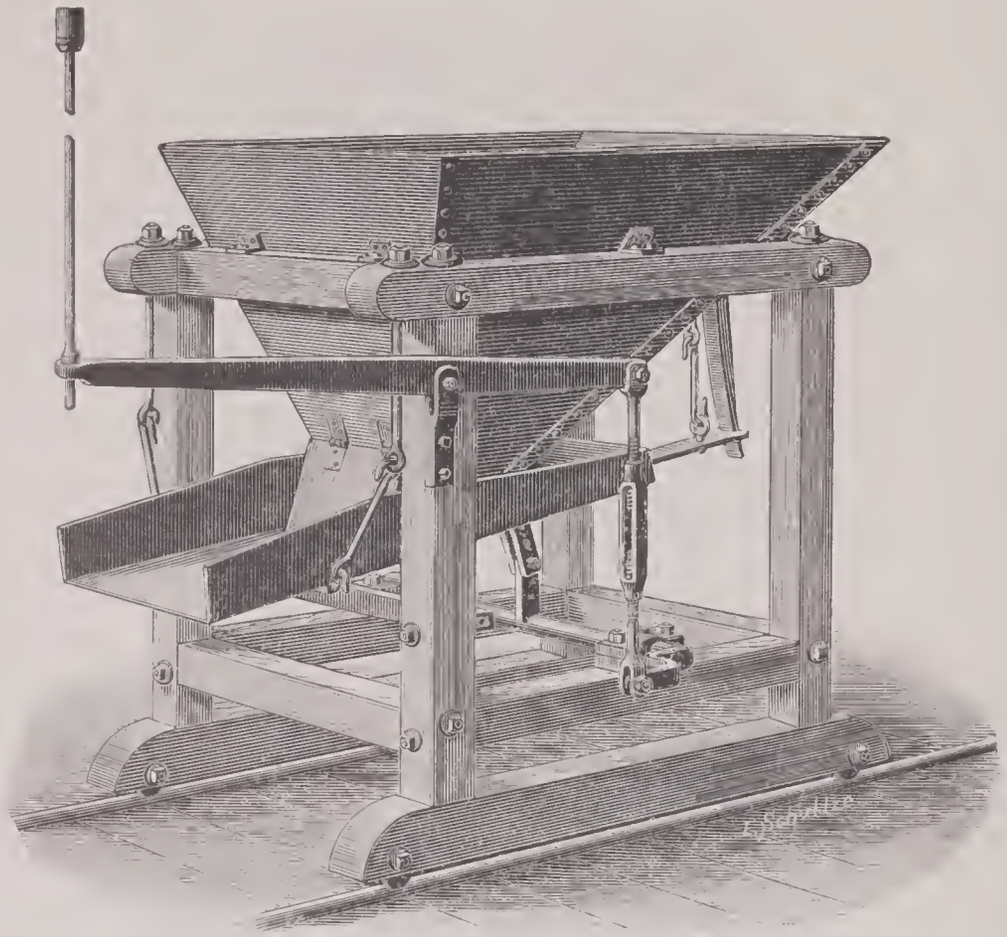
The illustration above shows the "Junior" Tullock Automatic Ore Feeder for Two and Three Stamp Batteries.

They are direct acting, and give a steady uniform feed. The swinging spout under the hopper is actuated by a lever which is struck by a collar fastened to one of the stems.

The feeders are supported upon rollers, so that they may be run back from the battery, if necessary.

	Weight.	Price.
Two-stamp Battery Feeder.....	280 lbs.	$55.00.
Three-stamp Battery Feeder.....	350 lbs.	65.00.

Further information given upon application.

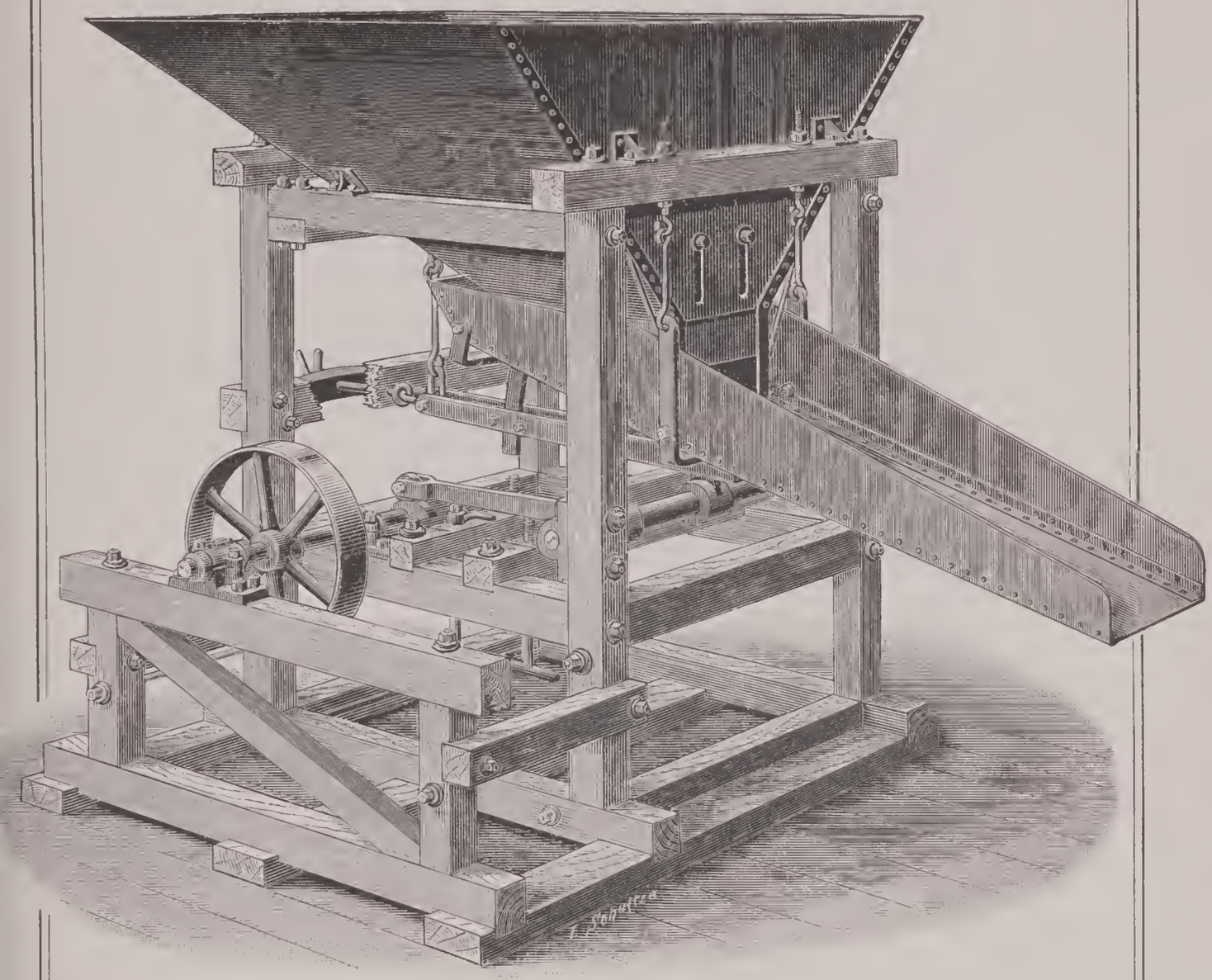


The Tullock Ore Feeder.

The above illustration shows the Tullock Automatic Ore Feeder. It is direct acting, and gives a regular and steady feed to the battery. The tappet strikes a wrought-iron bumper rod which runs up on the side of the stamp stem, and has a rubber bumper on the top end to ease up the shock. This rod is connected to a lever that gives the motion to the swinging spout under the hopper. There is an adjustable scraper in the back of the hopper, and at each motion of the spout a portion of the ore is scraped forward to the battery.

They are built with rollers on their supports so that they can be run back from the battery when any repairs are to be made. The feeders are made any height to suit the battery.

Weight, 700 pounds. Price, $100.00.



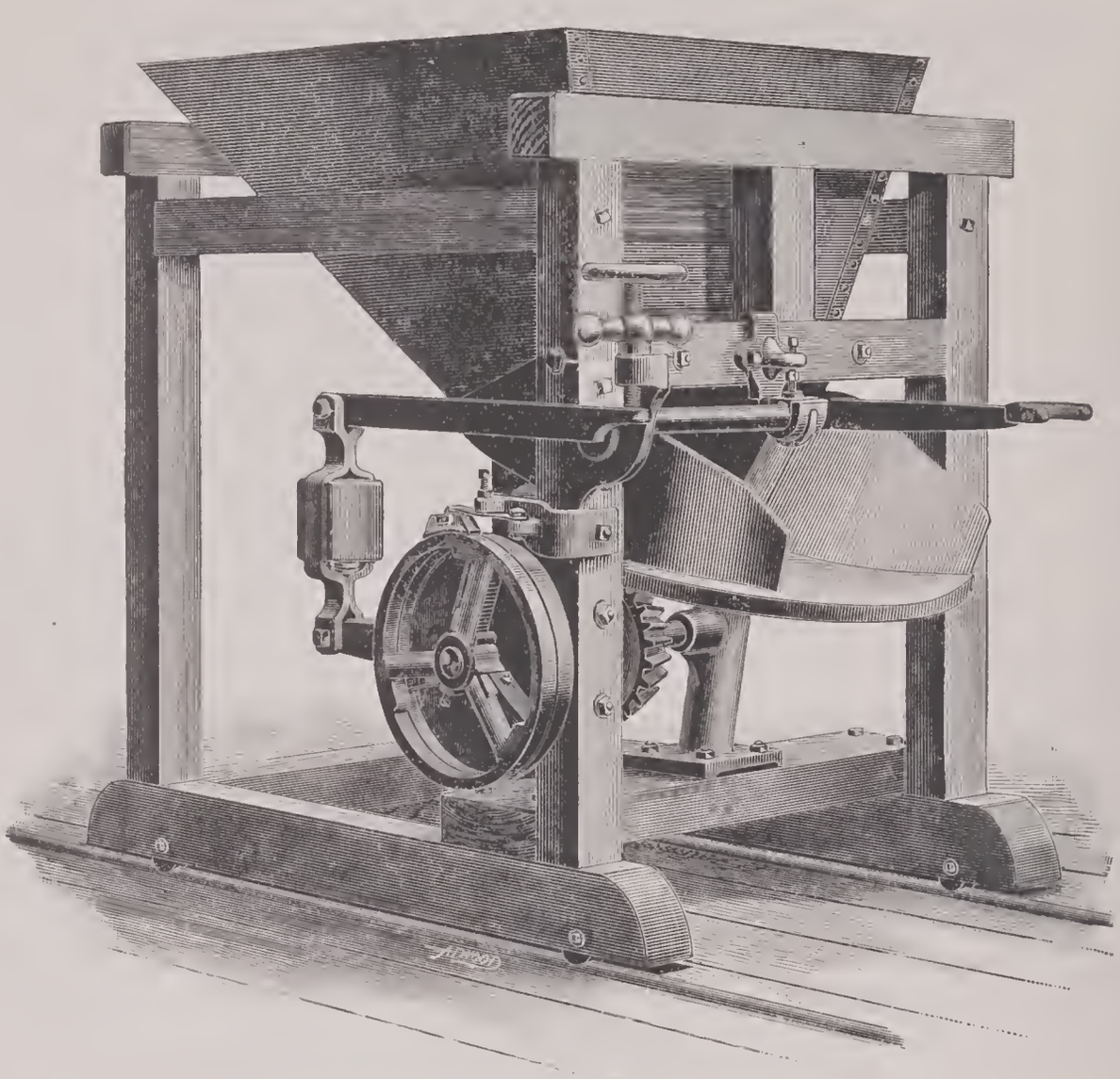
The Tullock Ore Feeder.

BELT DRIVEN.

The Tullock Ore Feeder, belt driven as shown above, is adapted to pulverizing machinery, where an intermittent discharge provided by the fall of a stamp is inapplicable.

The general arrangement is substantially the same as appears in the opposite illustration, the only changes being those involved in the different application of power.

Weight, 825 pounds. Price, $150.00.



Union Challenge Ore Feeder.

The illustration above shows the latest improved Union Challenge Ore Feeder.

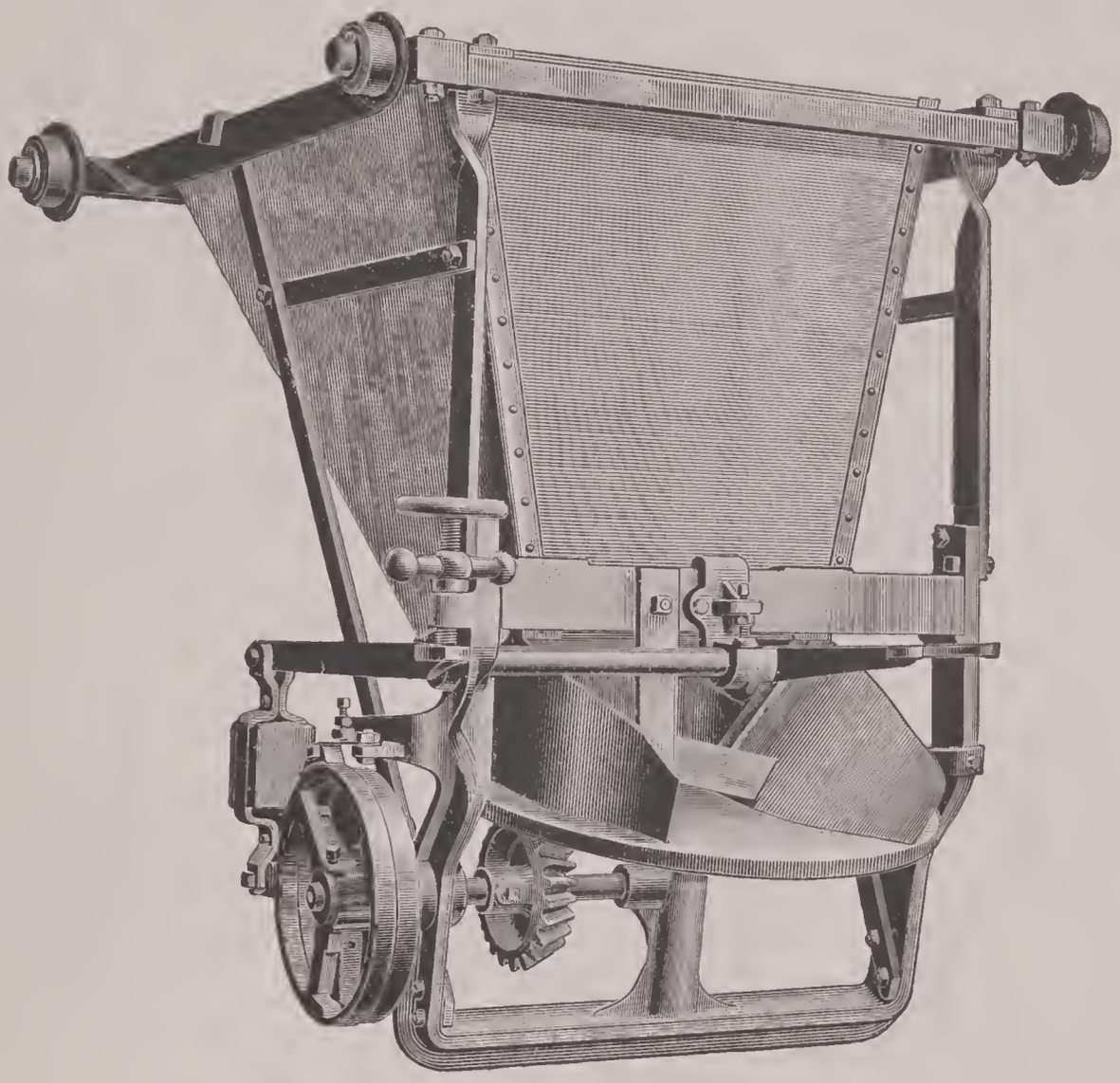
Uniform and accurate feeding is obtained even with wet or sticky ores, by means of an advancing plane or table to the line of discharge from which the ore is dropped into the mortar.

The rocker shaft is placed in front and receives its blow from a collar secured to the middle stem of a five-stamp battery.

A counter weight is used instead of a spring to return the rocker shaft to position, and is by far the best device in use, as it insures uniform motion, with fewest parts, and is always ready for operation. The jar is relieved by means of a spring under the weight, as will be seen in the illustration.

This feeder can be made, belt driven as shown on page 31, when desired.

Weight, 900 pounds. Price, $100.00.



Union Challenge Hanging Ore Feeder.

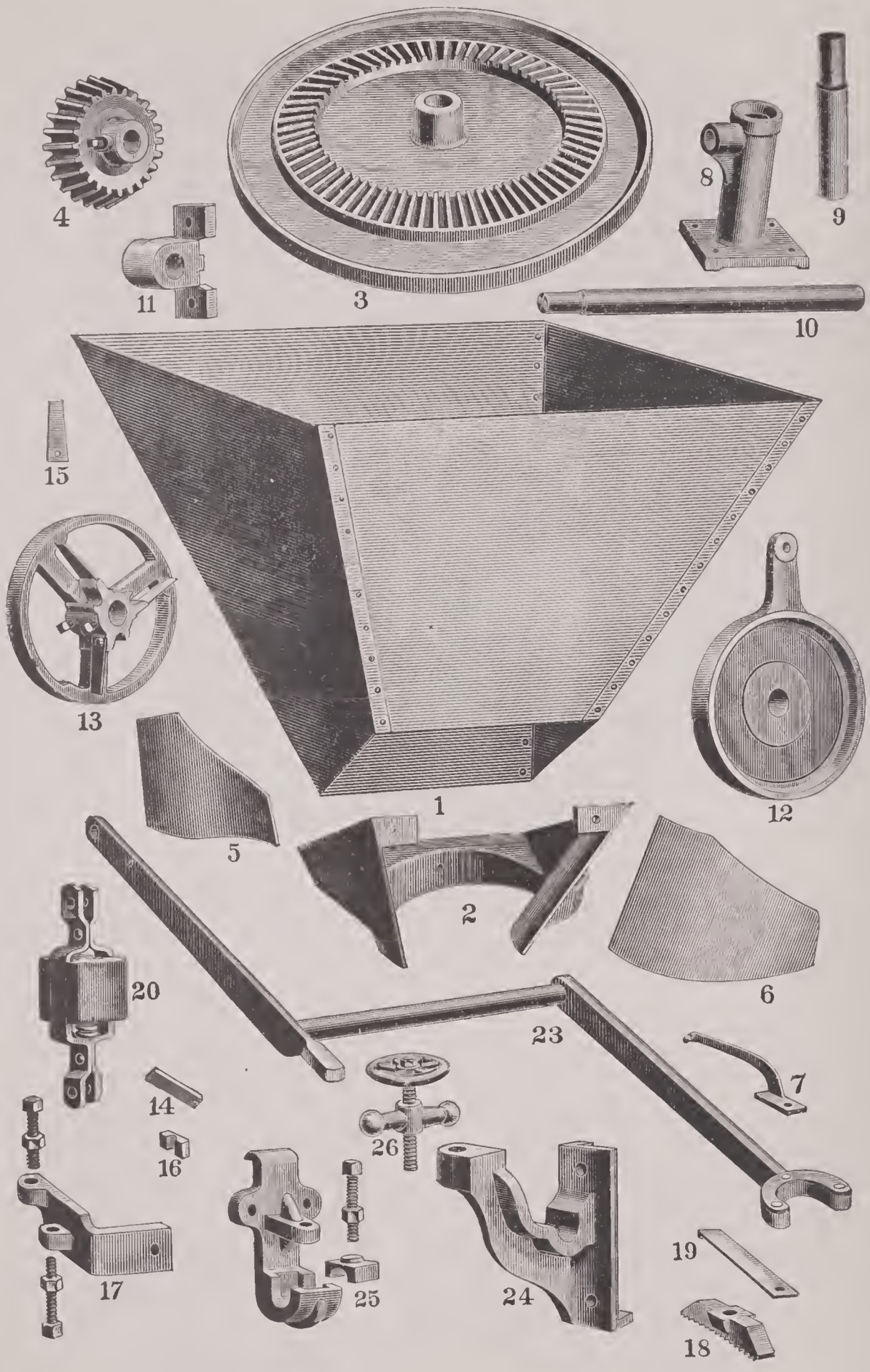
The illustration above shows a Union Challenge Hanging Ore Feeder.

In principle it is the same as the one illustrated and described on the previous page. The frame is made entirely of iron. It is provided at the top with four flanged wheels, for running on a track, back and forth as may be desired, in case of repairs or otherwise.

The main feature of the feeder is that it is entirely out of the way, and at all times allows a clear walk along the feed side of the mortar.

For general arrangement, see page 51.

Weight, 1,000 pounds. Price, $125.00.

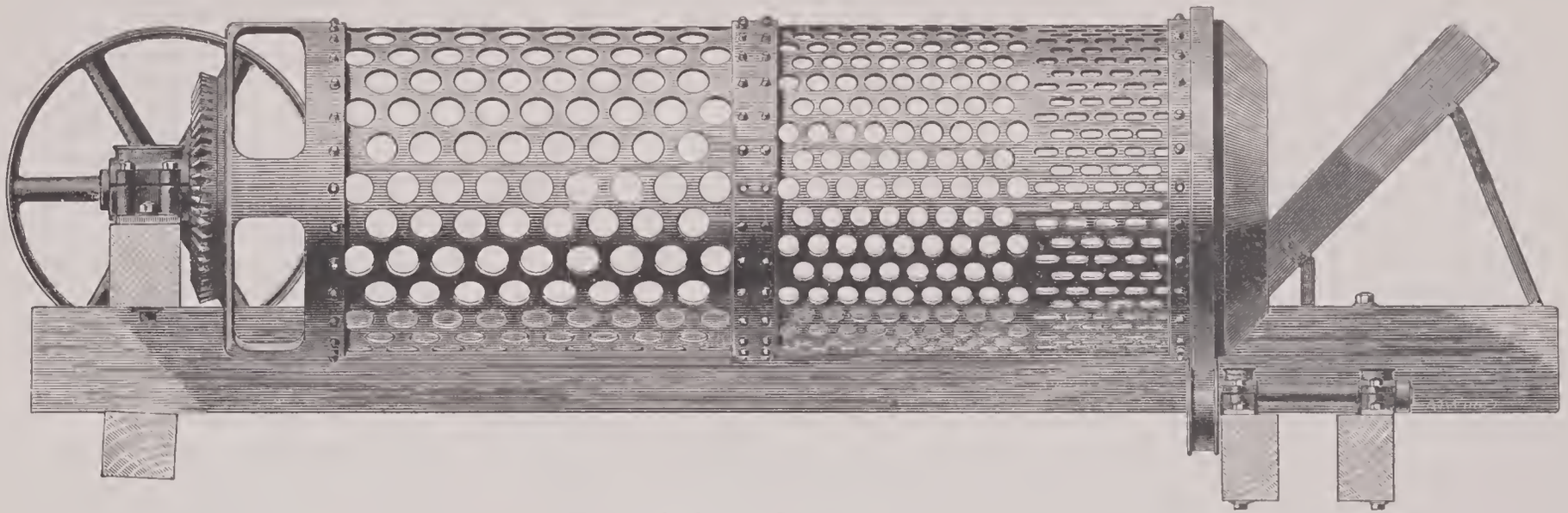


Union Iron Works Challenge Ore Feeder Details.

Union Iron Works Challenge Ore Feeder Details.

No. 1. Sheet Iron Hopper.
No. 2. Cast Iron Hopper.
No. 3. Table.
No. 4. Pinion.
No. 5. Small Side Plate.
No. 6. Scraper.
No. 7. Scraper Spring.
No. 8. Step.
No. 9. Spindle.
No. 10. Horizontal Shaft.
No. 11. Shaft Box.
No. 12. Friction Plate.
No. 13. Brake Wheel.
No. 14. Pawl.
No. 15. Steel Spring for Brake Wheel Pawl.
No. 16. Pawl Shoes.
No. 17. Brake Bracket.
No. 18. Brake Shoe.
No. 19. Brake Spring.
No. 20. Weight.
No. 23. Rocker Shaft and Levers.
No. 24. Fulcrum.
No. 25. Center Box for Rocker Shaft.
No. 26. Hand Wheel.
No. 26*a* Lock Nut.

See illustrations on opposite page.



Revolving Screens.

In making macadam it is essential to have the material thoroughly sized, as roadways and covering are built up of layers of different sized stone. No plant is complete without some method of screening.

The Revolving Screen we illustrate is one of the best and most durable made. It is constructed of different sizes to suit plants of any capacity.

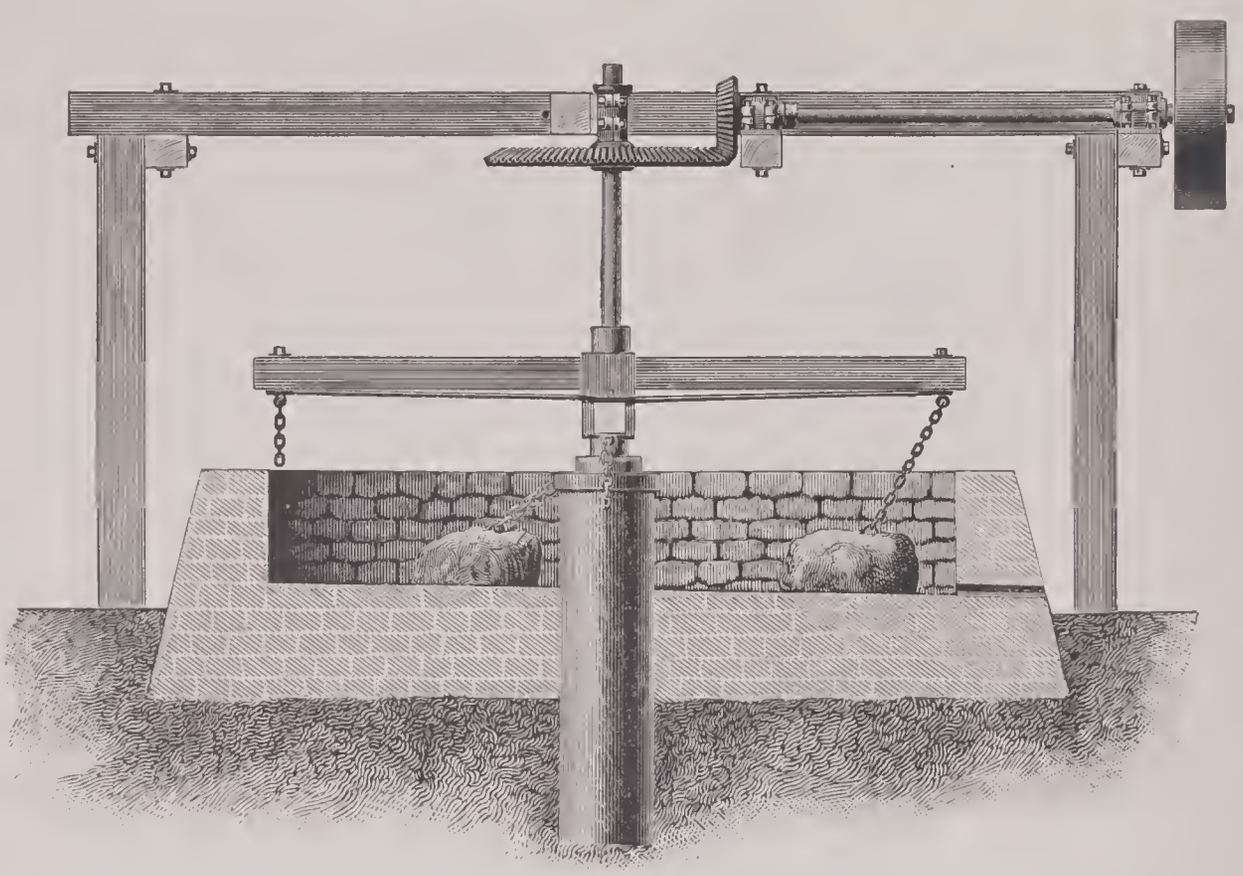
PRICE LIST, WEIGHTS, SIZES, ETC.

Screen.				Driving pulley.		Revolutions, per minute.	Weight, pounds.	Price.
Diameter.		Length.		Diameter, inches.	Face, inches.			
Feet.	Inches.	Feet.	Inches.					
2	0	6	0	20	4½	18 to 20	2,000	$250.00
2	6	7	0	28	4½	18 to 20	.....	.....
3	0	8	0	32	6½	18 to 20	.....	.....
3	6	9	0	36	6½	18 to 20	.....	.....
4	0	10	0	40	8½	18 to 20	.....	.....

Hand Mortar.

The Hand Mortar illustrated above is intended more especially for the use of prospectors, but will be found a useful adjunct in connection with the development of any mine.

Weight, 150 pounds. Price, $15.00.



The Arrastra.

The illustration above shows a transverse section of an Arrastra as commonly employed, though, for economy's sake, plate iron is frequently used in place of stone or concrete walls. In some instances the general design must be modified to suit the local conditions.

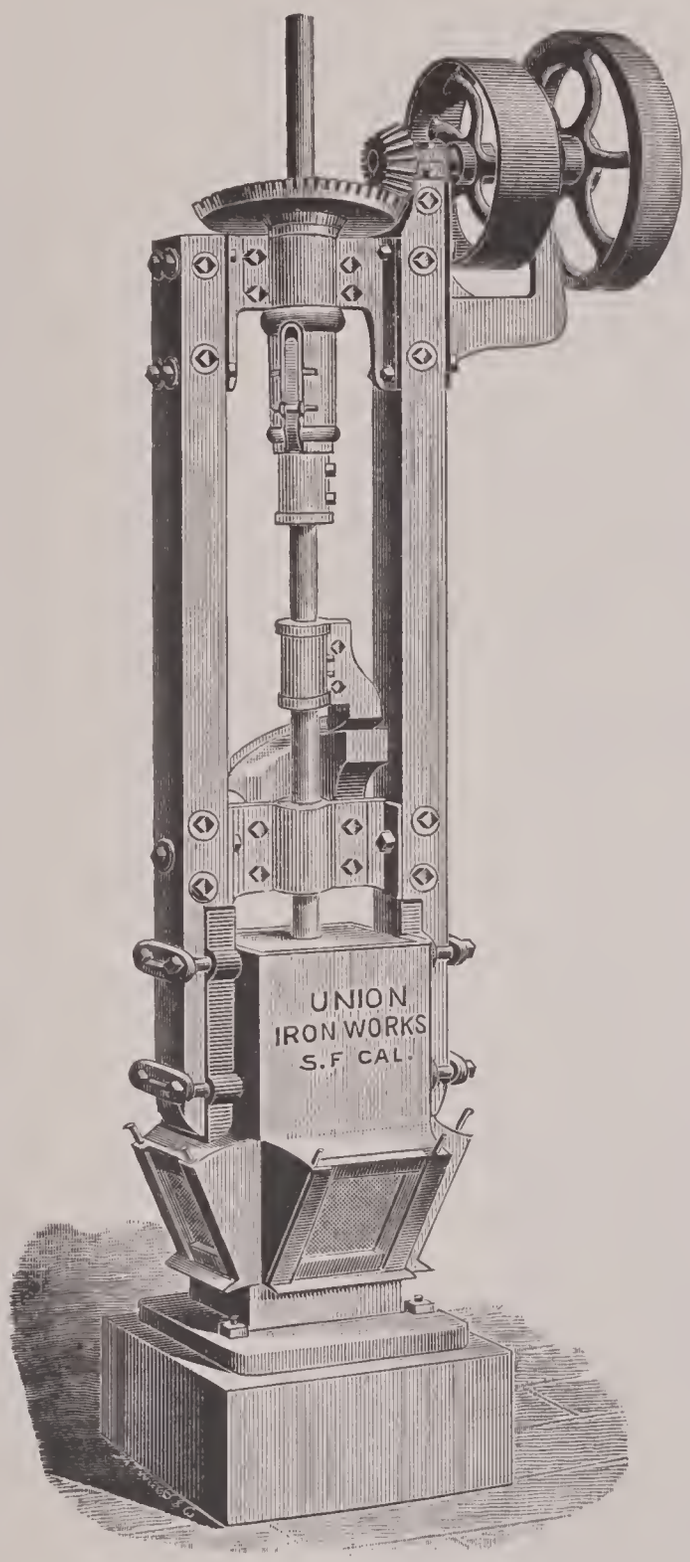
It is a very primitive machine, consisting of two or more heavy drags of stone (that will not easily assume a polished surface) slowly pulled around on a stone bed and grinding the ore under them. The diameters vary from eight to twelve feet, the width of the annular space from three to eight feet, and the height of the wall from one foot six inches to three feet. The drags should be as large as can conveniently be put in. Their weights vary about from two hundred to one thousand pounds respectively. Six or seven hundred pounds is the usual size employed, and can easily be drawn by a pair of mules. The speed is from six to twelve revolutions per minute, the former being that of animal and the latter that of water or steam power.

The arrastra was adopted to a great extent by the pioneers of California Gold Quartz Mining, from the practice of the old Mexican Silver Miners. It is still used to quite an extent, because it can almost wholly be built locally, is very cheap to erect, is simple to work, and a very efficient gold-saver. It is especially adapted for poor miners that have little or no capital to buy small mills to work their own claims. Where the ore is rich and the veins small, the arrastra cannot be excelled for the prospector and pioneer in remote and new mining regions. Its use should be confined to free milling ores, containing only a small percentage of sulphurets, such as compose the out-crop of most quartz ledges.

IRON WORK FOR ONE TWELVE-FOOT ARRASTRA.

Weight, 2,400 pounds. Price, $200.00.

Further information cheerfully given upon application.



One-stamp Mill.

The One-stamp Mill, illustrated herewith, is made in three different sizes, as shown in table below. It is particularly designed for prospecting and development work, is self-contained, makes an up-to-date battery, and serves well the purpose for which it is intended.

It differs from other types of batteries in that it has a revolving tappet instead of a revolving cam. The cam and tappet are both of peculiar construction, and the latter is secured to the stem of the stamp so as to revolve with it at the same time that it is lifted. The cam is a plain curved incline, mounted on a rubber cushion to prevent jarring. The stamp is raised by the tappet rising on the curved cam, and, as it drops off the cam, a grinding operation is produced by the rotation of the stamp, until it is again lifted. This ingenious arrangement gives both a crushing and a grinding action to the stamp, a very valuable combination.

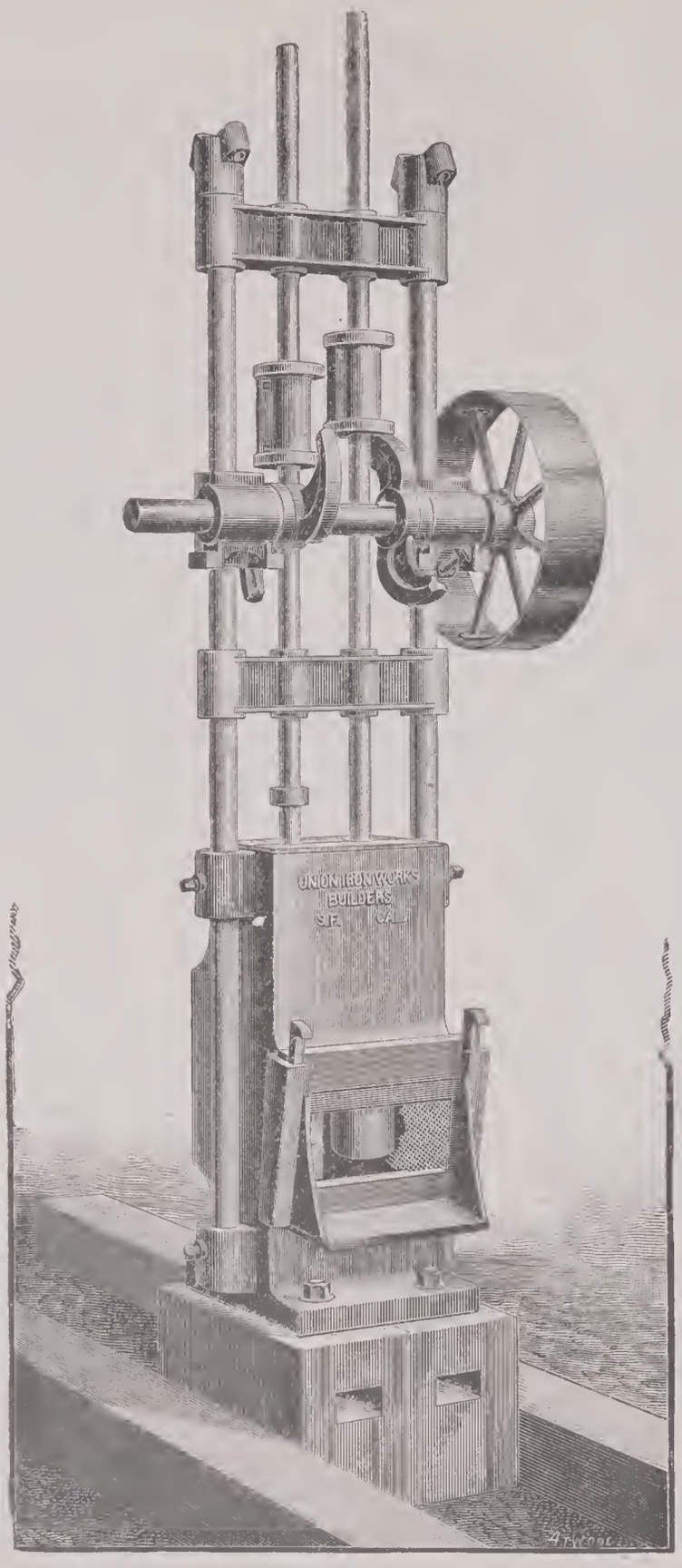
There are many of these mills in use, and give excellent satisfaction.

Further information cheerfully given upon application.

PRICE LIST, SIZES, ETC.

No.	Horse-power required.	Tons capacity per 24 hours.	Slotted screens to be used.	Diameter of pulley.	Revolution of pulley.	Drop. In.	Drops per minute.	Weight of heaviest piece.	Weight of stamp.	Weight of mill complete.	Cash price complete.
0	1	1	No. 6	16 x 3½	150	4	150	135	125	740	$150.00
1	2	3	No. 6	18 x 5½	195	5	130	375	450	2,200	300.00
2	3	5	No. 6	22 x 6½	190	5	125	1,250	900	4,000	450.00

Nos. 0 and 1 are portable, and capable of being easily taken to pieces and packed on mules or horses.



Patented, Aug. 3, 1897. No. 27,479.

IRON FRAME

Two-stamp Prospecting Battery.

SELF-CONTAINED.

Two-stamp Iron Frame Prospecting Battery.

To meet the demand for a small Prospecting Battery, that may be easily and cheaply erected, we have designed the Portable Iron Frame Battery, shown on the opposite page. It is wholly self-contained, and can be erected by any one, all parts being fitted and plainly marked to place before leaving the works.

The mortar block (the upper portion of which appears in the cut) is similar to that required for any other form of battery, 20″x24″, of a suitable length. It can be hewn out of a log or built up of 2″ plank, spiked together; this makes an excellent block, and is often used where timber is scarce and transportation is difficult.

The mortar is of the latest design, and can be fitted with inside plates for battery amalgamation if desired, and weighs 1,200 pounds.

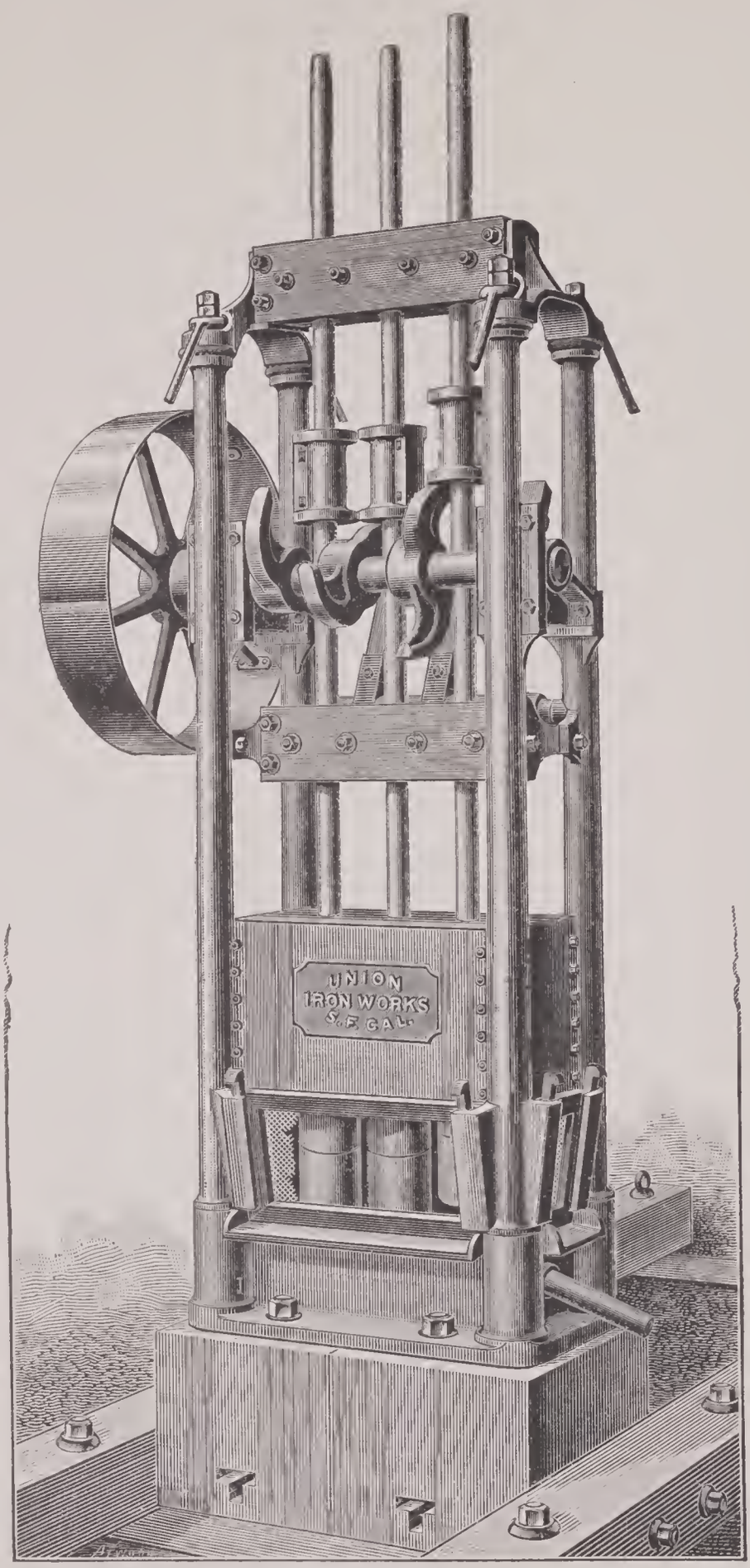
These mills are as perfect in detail and as thoroughly well built as those of larger capacities.

Weight of stamps	275 pounds.
Capacity per day	2 tons.
Power required	1½ horse-power.
Weight of battery complete	3,000 pounds.
Price, f. o. b. San Francisco	$250.00.

Including battery complete, above block, as shown, with screen and keys and holding-down bolts.

If made in sections for mule-back transportation, $25.00 extra.

Automatic feeder for this battery shown on page 29.



Three-stamp Pacific Iron Frame Prospecting Battery.

Three-stamp Pacific Iron Frame Triple Discharge Prospecting Battery.

On the opposite page is illustrated a Portable Three-stamp Battery. It is entirely self-contained, and ready for operation as it leaves the works.

Its construction is simple, and the parts are marked to place, so that it may be easily and quickly erected.

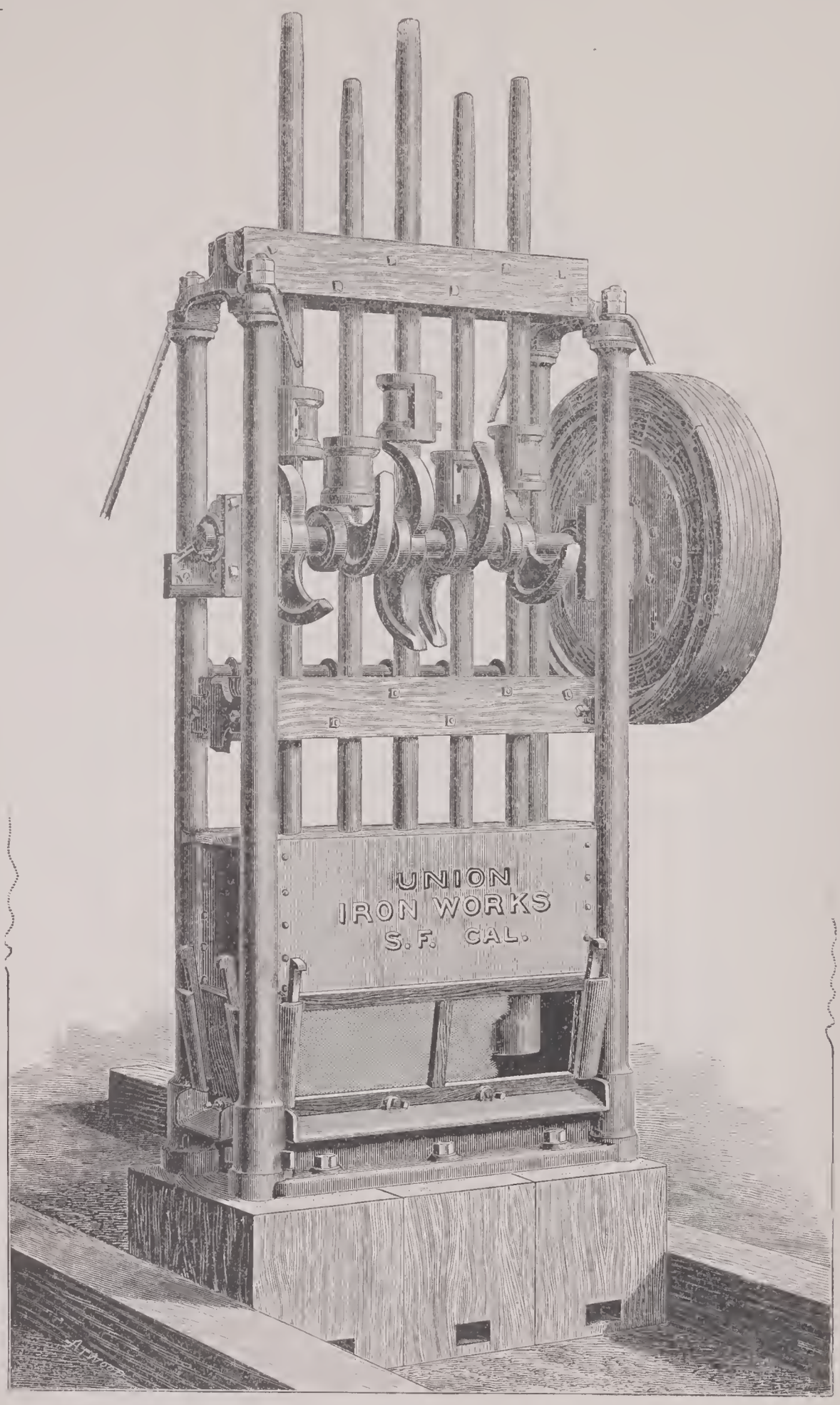
The heaviest piece is the mortar base, which weighs 1,350 pounds. It is made with three discharge openings, which are provided with screens and keys.

We have built a number of these for prospecting work, and they give the best of satisfaction.

Weight of stamps	350 pounds.
Capacity per day	4 tons.
Power required	2½ horse-power.
Total shipping weight	5,000 pounds.
Price, f. o. b. San Francisco	$425.00.

When made in sections for mule-back transportation, price additional, $40.00.

Automatic feeder for this battery shown on page 29. Further information upon application.



Five-stamp Pacific Iron Frame Battery.

Pacific Iron Frame Battery.

The Pacific Iron Frame Battery, illustrated on the opposite page, is made in four different sizes, as shown by the table below. It is particularly designed for prospecting or development work, and serves the purpose well. All parts are constructed in such a way that, when taken apart and moved to another prospect, anyone can put the different pieces together and quickly have a rigid battery ready for practical operation. We recommend it for above purposes; it is portable, requires no skilled mechanic, and gives good results.

WEIGHTS, PRICES, ETC.

Number of stamps in battery.	Weight of stamps, pounds.	Capacity per day, tons.	Horse power required.	Total weight, pounds.	Price f. o. b. San Francisco	Additional charge when sectional.
1	500	2	1	4,000	$320.00	$40.00
2	500	4	2	4,600	375.00	40.00
3	500	6	2½	6,600	500.00	50.00
5	500	9	5	11.500	650.00	80.00

EXTRAS.

Shoes and Dies, per set (5 each)	$40.00
Tappets, each	10.00
Cams, each	12.00
Stamp Heads, each	9.00
Stems, each	20.00
Screens, each	4.00

Union Ore Feeder for feeding Batteries, 900 lbs. . . $100

Illustrated on page 32.

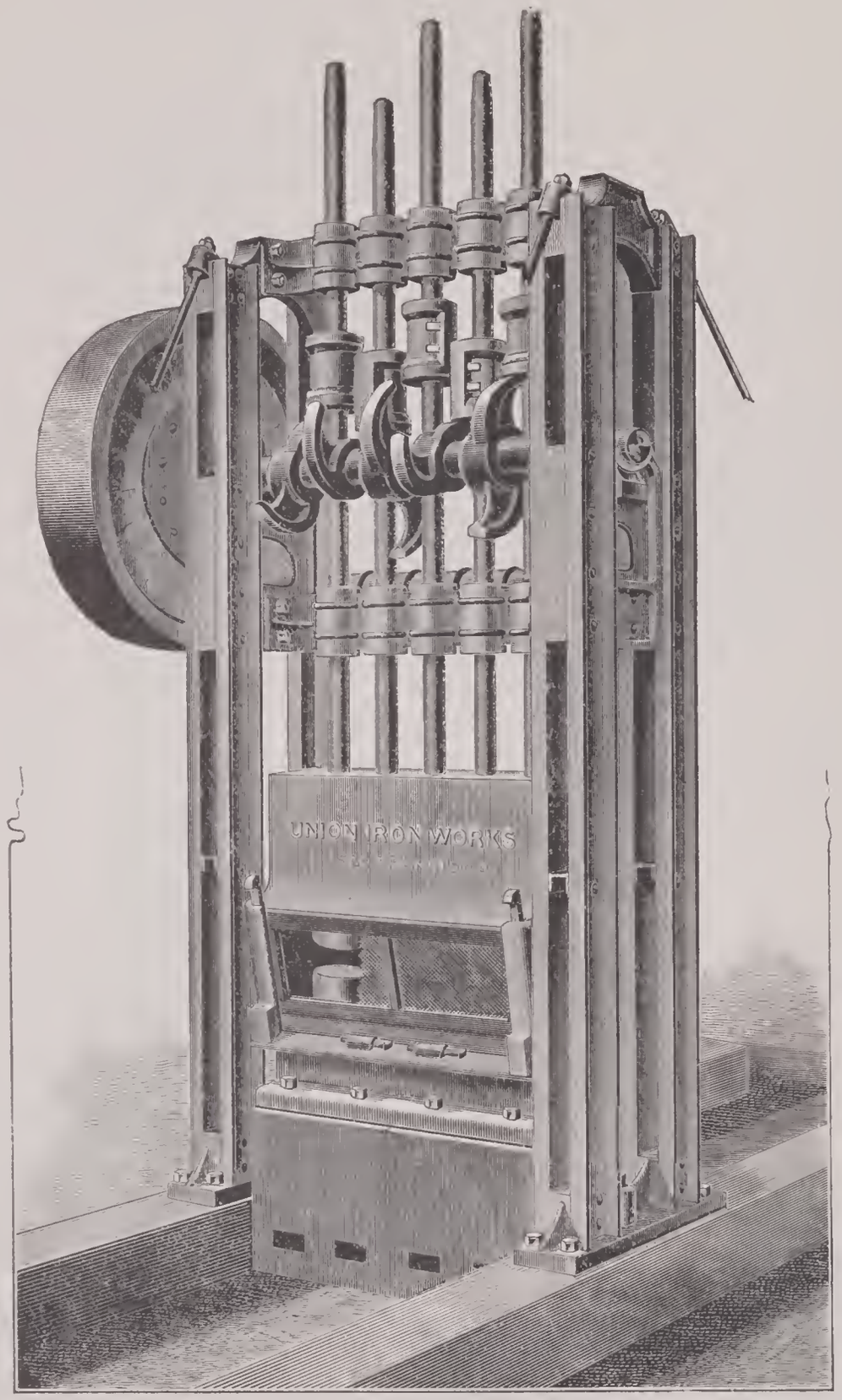
Parties ordering these mills for use in distant localities will find it desirable to have a few extras, such as in all mills are subject to wear and the possibility of breakage. We would recommend that with each Five-stamp Battery the following extras be included:

3 extra sets, Shoes and Dies. **1 extra Tappet.**
1 extra Cam. **1 extra Stamp Head.**
6 extra Screens.

When these batteries are used for working gold ores, a copper apron plate should be used, which is electro-silver-plated with one ounce of silver to each square foot of apron. The size of this apron depends upon the number of stamps used, but should contain six square feet of surface for each stamp, and costs $25, thus making the apron plate for a Five-stamp Battery cost $125.00.

If the ore contains valuable sulphurets, these should be saved, and for this purpose we recommend that a "Union" Concentrator be used. These machines will not only save the sulphurets, but also catch any amalgam or gold which may pass the plate or apron.

Further particulars given upon application.



Union Iron Frame Battery.

Union Iron Frame Battery.

The Union Iron Frame Battery, illustrated on the opposite page, obviates all objections and meets fully the demand for a cheap and portable mill complete in itself, that can be put up without any skilled labor—conditions of great importance in many mining districts,—and that can be absolutely depended upon for the best results. In general construction, as will be seen, it is precisely the same as the most improved form of battery intended for wood work.

The mortar used in this battery is the latest improved standard mortar, being securely fastened to the mortar block by holding-down bolts. The columns are made of channel iron, to which the top bridge-tree, cam-shaft boxes and base piece are securely bolted or riveted, combining strength with durability and neatness of design.

The mortar block, the upper section of which is shown in the engraving, is the same as that required for any other style of battery. It is ordinarily eight to ten feet in length and made of two-inch plank, spiked and bolted together. This makes a good block, and, in localities difficult of access, can be easily transported on either mule-back or otherwise.

When made in sections, the mortar is cut into six pieces or more, of full packing weight, and provided with reamed bolts for fastening together when in place.

The mill being complete, no millwright or other skilled labor is necessary in setting up. The pieces are so marked that anyone with ordinary intelligence can easily and quickly put it up in good running order.

A single battery of five stamps makes a perfect mill. When larger capacity is wanted any additional number may be added, making a ten, twenty or forty stamp mill as desired; as may be mentioned, this Company having furnished 100 stamps of this design to the famous Compañia Huanchaca de Bolivia, also twenty stamps to the Amarillas Mine, Mines Prietas, Sonora, Mexico.

Although adapted to any locality, they have come more especially into use in Mexico, Central and South America and Africa, where facilities for securing available timber and having it framed are limited. The many advantages of this battery for such a location are therefore most apparent.

	Weight.	Price.
1. Stamp Battery (750 lbs.)	6,500	$ 450.00
2. " " "	9,000	675.00
3. " " "	12,500	875.00
5. " " "	17,200	1,225.00

When made in sections for mule transportation, add 12½ per cent to above prices.

Shoes and Dies, per set (5 each), white iron	$50.00
Shoes and Dies, per set (5 each), steel	90.00
Tappets, each	15.00
Cams, each	18.00
Stamp Heads, each	12.00
Stems, each	27.00
Screens, each	5.00

Union Ore Feeder for feeding Batteries, 900 lbs. - - $100.

Illustrated on page 32.

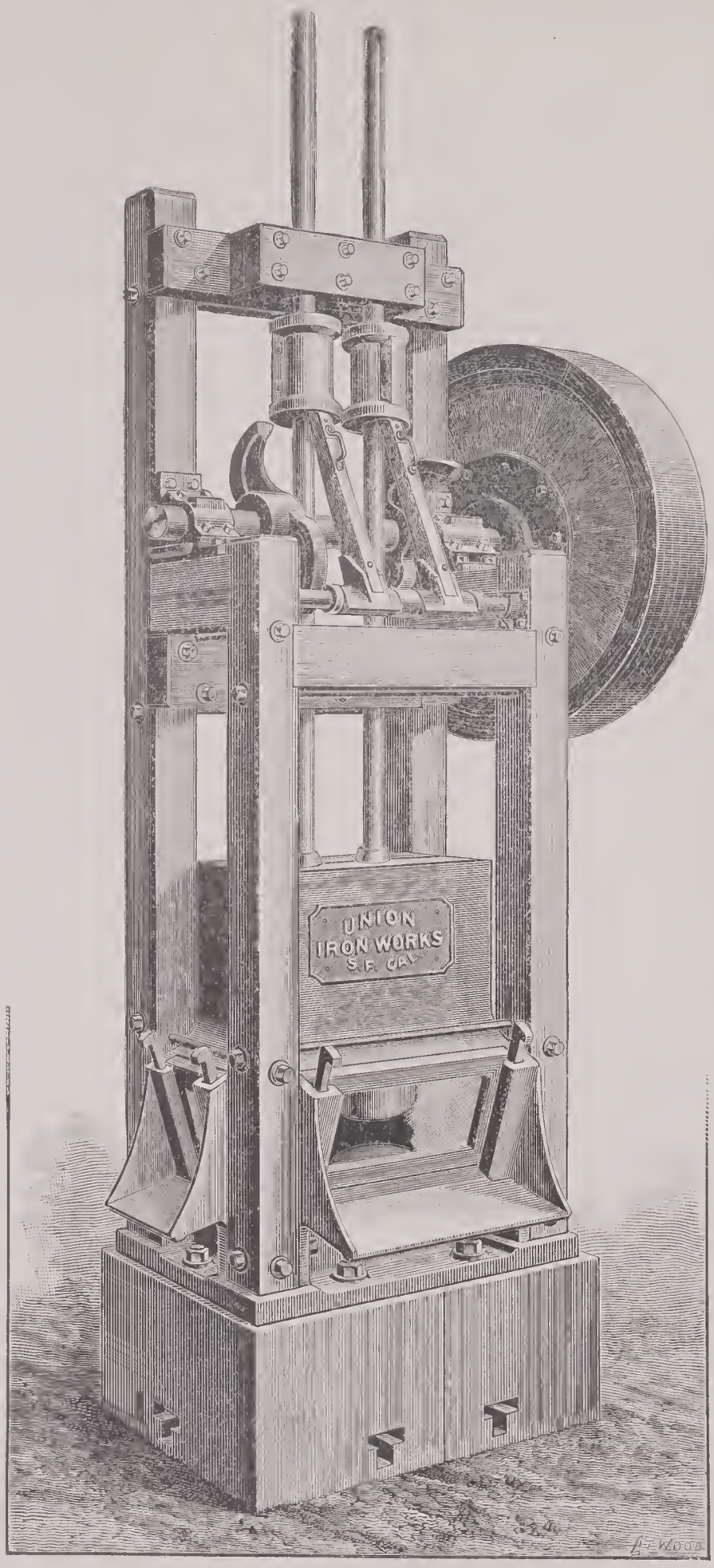
Parties ordering these mills for use in distant localities will find it desirable to have a few extras, such as in all mills are subject to wear and the possibility of breakage. We would recommend that with each Five-stamp Battery the following extras be included:

3 extra sets, Shoes and Dies. 1 extra Tappet.
1 extra Cam. 1 extra Stamp Head.
6 extra Screens.

When these batteries are used for working gold ores, a copper apron plate should be used, which is electro-silver-plated with one ounce of silver to each square foot of apron. The size of this apron depends upon the number of stamps used, but should contain not less than six square feet of surface for each stamp, and costs $25, thus making the apron plate for a Five-stamp Battery cost $125.00.

If the ore contains valuable sulphurets, these should be saved, and for this purpose we recommend that a Union Belt Concentrator be used. These machines will not only save the sulphurets, but also catch any amalgam or gold which may pass the plate or apron.

Further details furnished upon application.



Two-stamp Wood Frame Battery.

Two-stamp Wood Frame Battery.

TRIPLE DISCHARGE.

On the opposite page is shown a Two-stamp Triple Discharge Wood Frame Battery. As will be seen in the illustration, the battery posts rest on the mortar base, designed especially large for the purpose, making the complete battery self-contained and easily erected. Its capacity is nearly that of an ordinary Five-stamp Mill and is particularly adapted to ores carrying a high percentage of sulphurets, where the process of concentration is essential. The iron work throughout is practically the same as used in our large standard batteries, the cams are of the Union self-fastening type and the tappets, stems, etc., all of the best material.

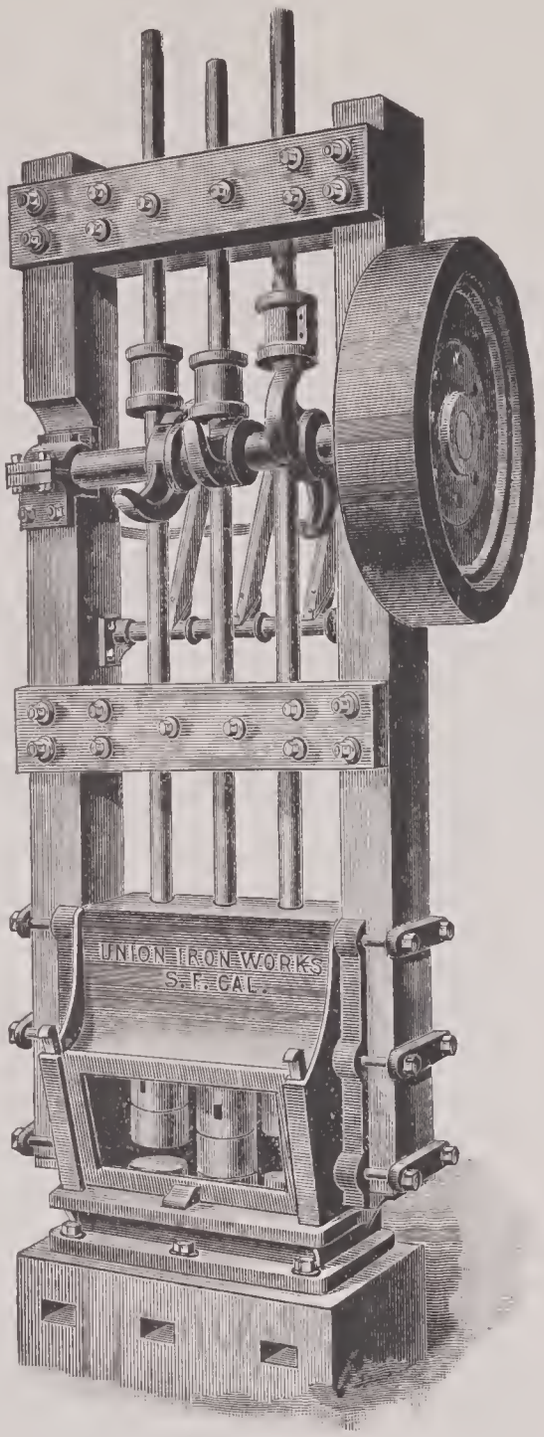
The engraving is so complete in detail that little or no description is necessary.

The heaviest piece is the mortar weighing 3,600 pounds.

Weight of stamps	850 pounds.
Capacity per day	8 tons.
Power required	3½ horse-power.
Shipping weight	10,000 pounds.
Price, f. o. b. San Francisco	$540.00.

Automatic feeder for this battery shown on page 29.

In furnishing machinery for a mill of any capacity, we provide without additional charge complete plans for erecting.



Three-stamp Self-contained Wood Frame Battery.

SINGLE DISCHARGE.

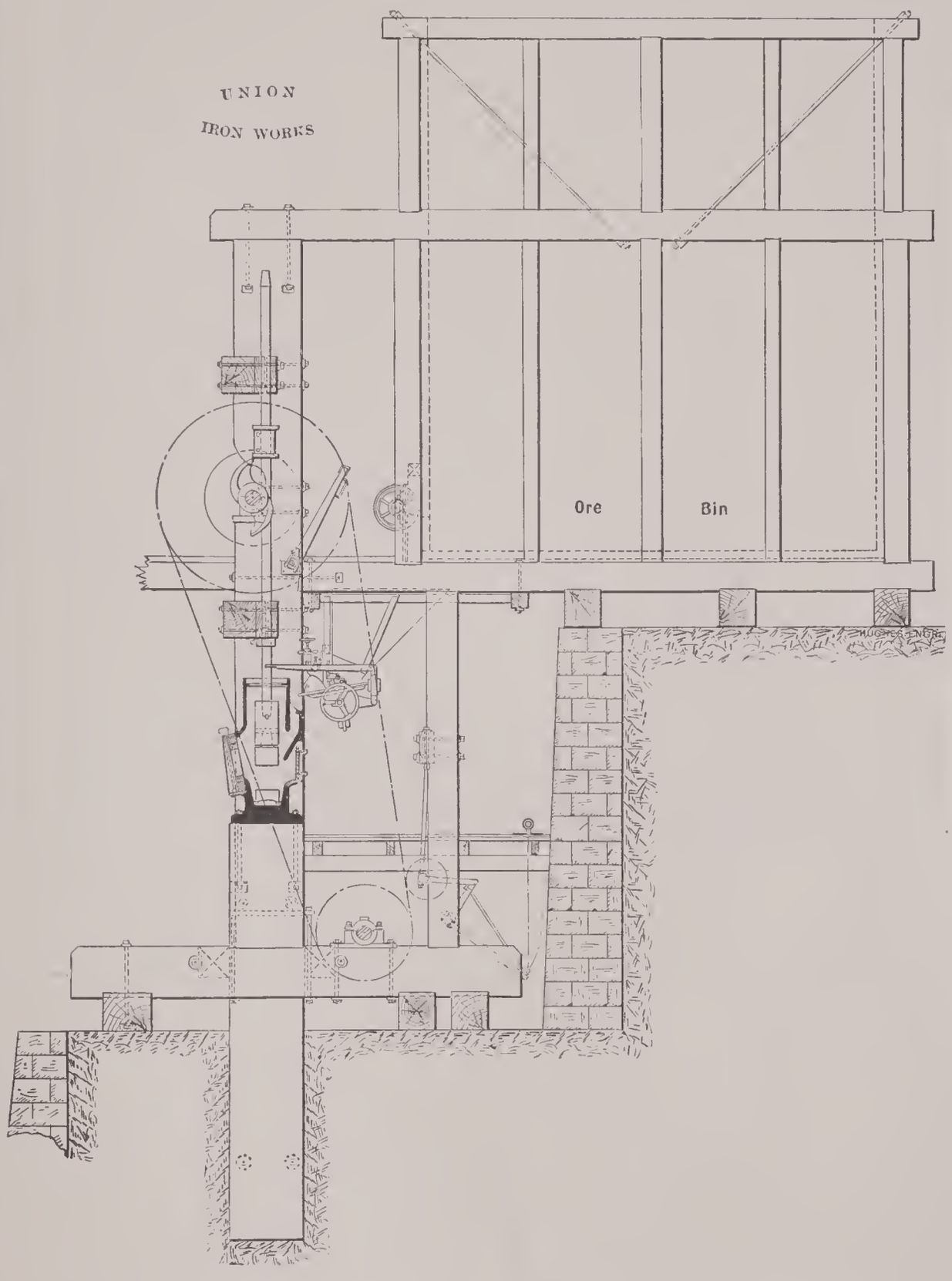
The illustration above shows a Three-stamp Single Discharge Wood Frame Battery.

The mortar is provided with brackets and seats, in which the battery posts are firmly secured, as shown.

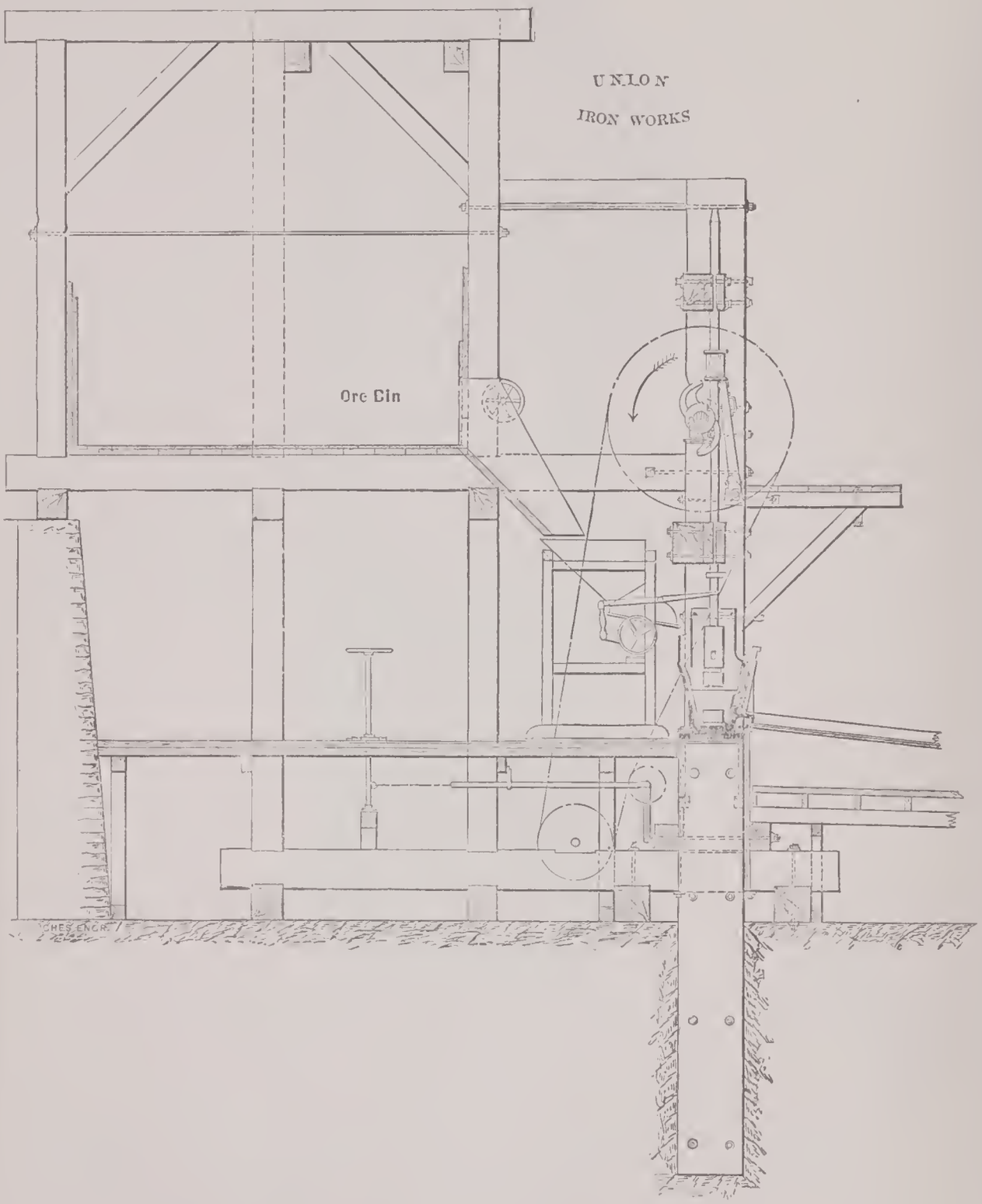
The battery is complete above the mortar block, and is easily erected, all parts being fitted and marked to place before leaving the works.

Weight of stamps	800 pounds.
Capacity per day	10 tons.
Power required	4½ horse-power.
Shipping weight	10,000 pounds.
Price, f. o. b. San Francisco	$575.00.

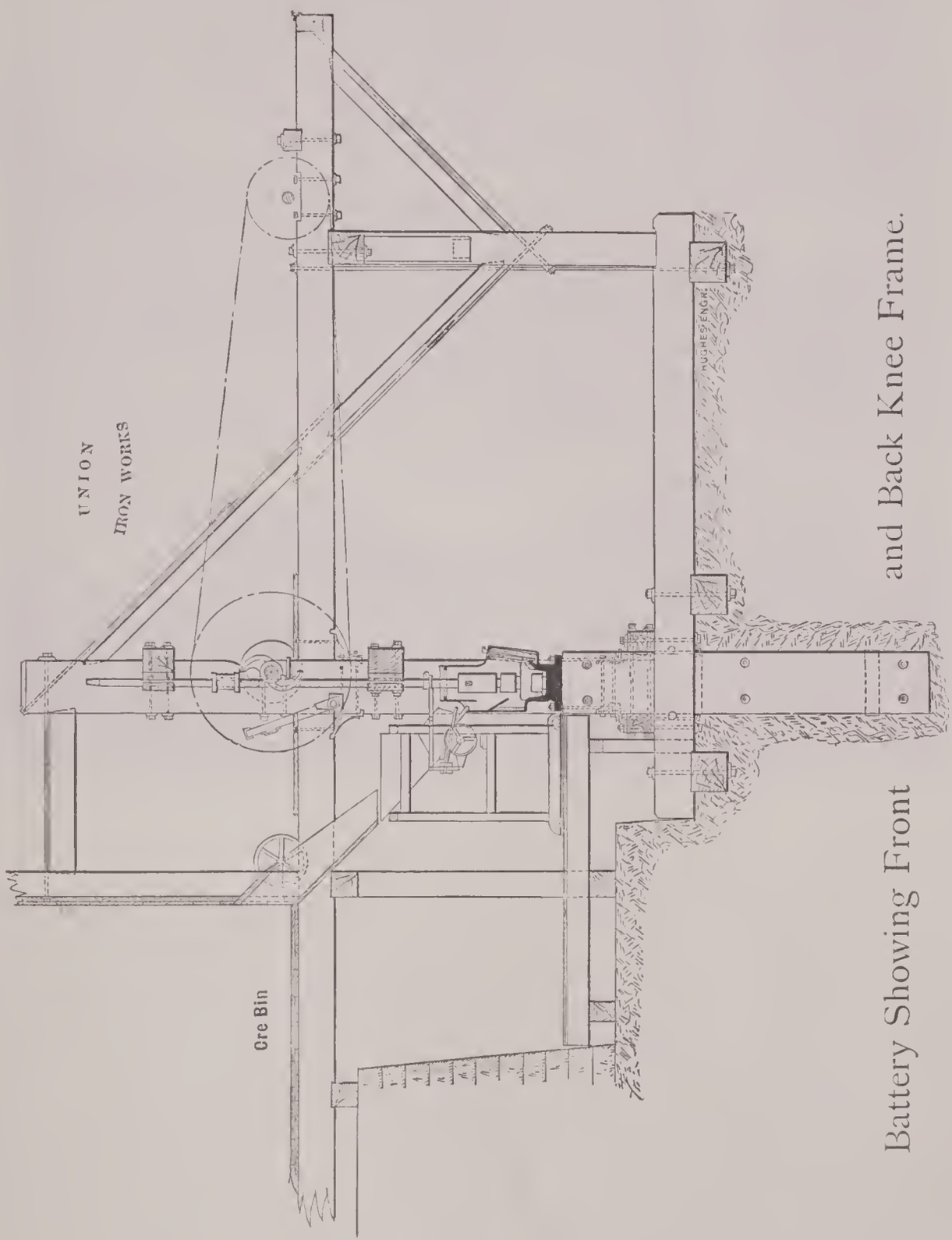
Automatic feeder for this battery shown on page 29.



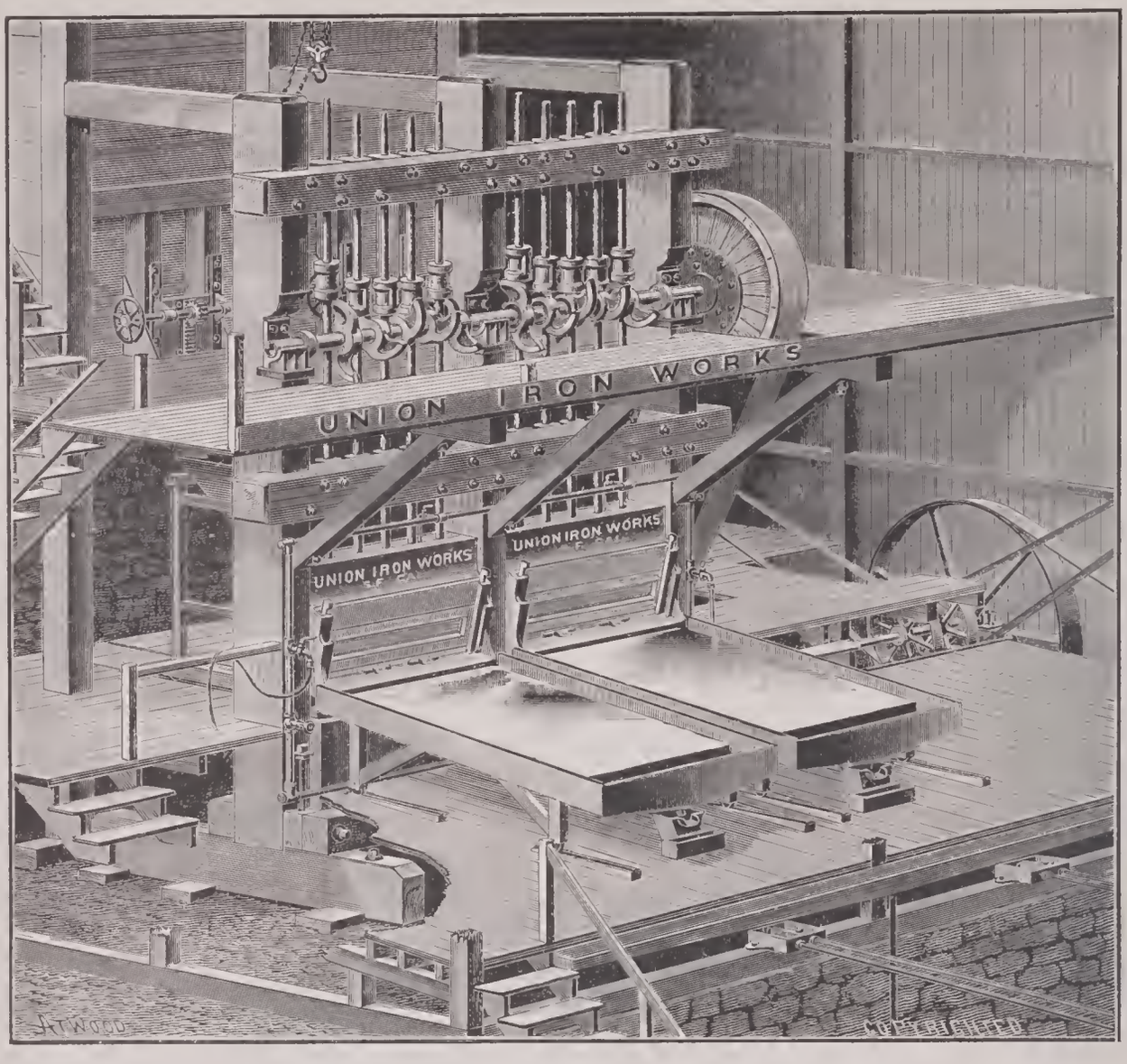
Back Knee Battery Frame with Ore Bin and Hanging Ore Feeder.



Battery with Back Knee Frame, showing Tightener, Feeder, Ore Bin and Gate.



Battery Showing Front and Back Knee Frame.



Ten-stamp Battery.

The Ten-stamp Wet Crushing Battery illustrated above is representative of the latest and best practice, and is our standard design.

In this battery the cams are all mounted on one cam shaft, placed for convenience on the front side of the battery posts, and driven from a countershaft below the feeder floor, back of the battery. A tightener pulley is employed by which the stamps can be stopped or put in motion without stopping the driving pulley. The pulley on cam shaft is built of wood on cast-iron flanges, which is necessary, as an iron pulley subjected to the rapid succession of jars, caused by the dropping of the stamps, would soon crystallize and break.

The cams are of the Union improved self-fastening type (see page 65), reliable in every particular, and give excellent satisfaction.

The cam-shaft boxes or knee boxes (see page 68) are of the most improved form, have no cap, and are provided with drip grooves around the base for catching the waste oil.

The mortar is our standard California pattern (see page 59), embodying all practical features suggested through years of experience.

The stamp stems, tappets, heads, shoes and dies are all of the most improved design (see pages 63, 64 and 69).

This battery throughout is modern, complete, efficient and up-to-date in every respect.

We furnish complete working drawings for setting all our machinery and plans for frames also, so that any competent millwright can build them and assemble the parts.

The engraving shows, besides the complete battery, the ore-bin gates, automatic ore feeders and copper silver-plated amalgamating plates.

See opposite page for general specification.

General Specification of a Ten-stamp, Wet-crushing Battery.

(ONE CAM SHAFT.)

[See illustration on opposite page]

2 High mortars, of improved pattern, single discharge, planed on bottom and for screen frames.

2 Screen frames of soft pine, fitted to mortars.

2 Screens, steel wire or punched.

8 Gib-headed keys for screen frames.

2 Sheets of rubber, for mortar cushions.

10 Stamp dies.

10 Stamp shoes.

10 Stamp heads, bored for stems.

10 Stems of refined iron or mild steel, both ends tapered.

10 Tappets, with wrought-iron gibs, two steel keys.

10 Union self-fastening cams, 5 right and 5 left hand, double armed.

1 Cam shaft of hammered iron or steel, turned and marked for each cam.

3 Cam shaft boxes, bored and planed on bottom and back.

2 Wrought-iron cam shaft collars, with steel set screws.

1 Pair cast-iron sleeve flanges, 36″ diameter, with wood pulley 72″x16″, built up of clear, seasoned pine, and fitted to flanges, which are bored and keyed to the shaft.

2 Upper and two lower hardwood guides, bored for stems, with proper bolts.

2 W. I. jack shafts.

4 C. I. jack shaft bearings, with lag screws.

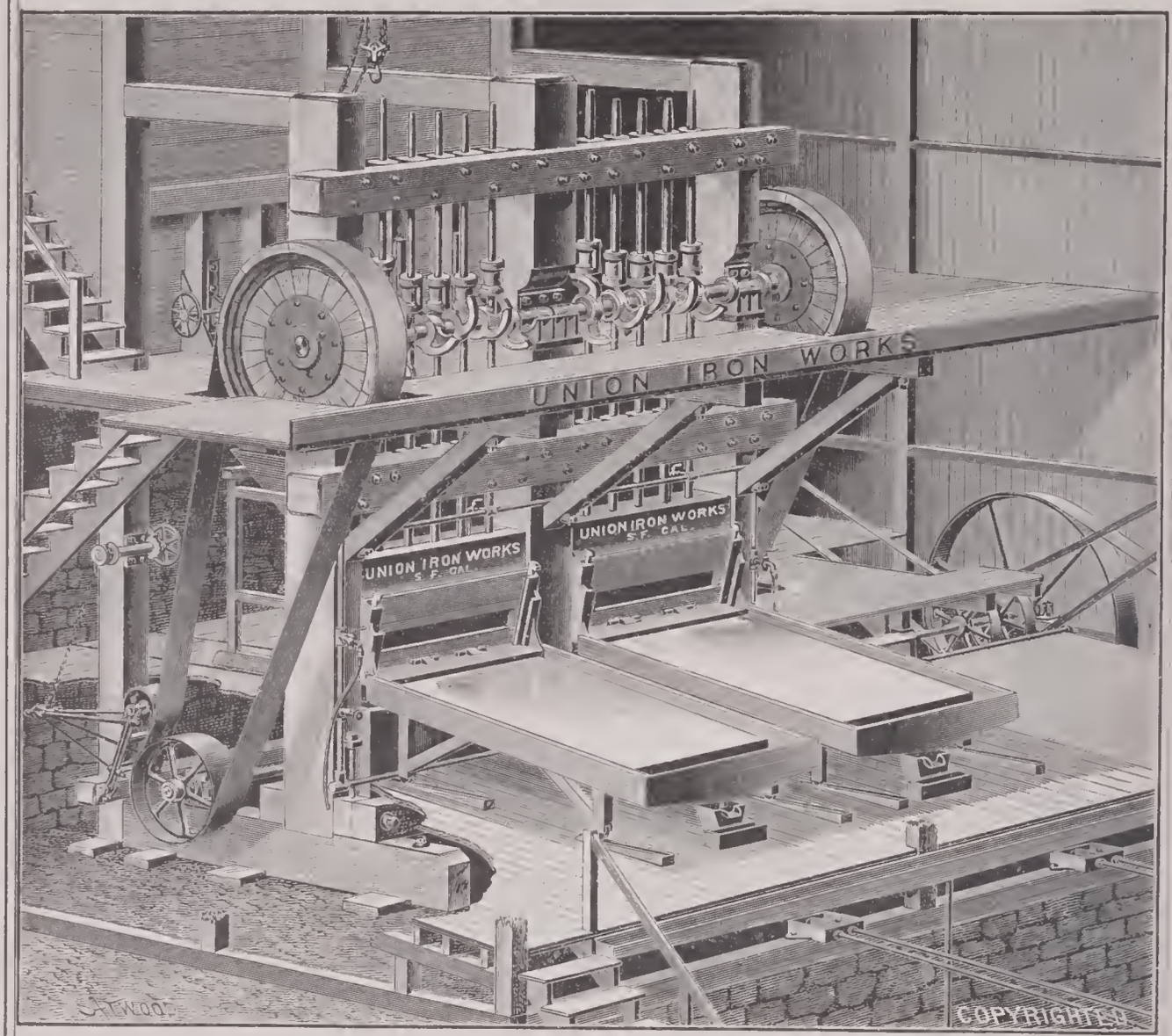
10 Latch sockets with fingers, lined with leather.

10 Wood fingers, mounted complete.

1 Set of water pipes, valves and fittings, as required.

All bolts, nuts, rods and washers for a 10-stamp battery frame, complete.

1 Steel key for loosening shoes and stamp heads.



Ten-stamp Battery.

(TWO INDEPENDENT CAM SHAFTS.)

The Ten-stamp Battery illustrated above is in general design the same as shown and described on page 54, with the exception that the cams are mounted on two separate shafts and each having its driving pulley.

This battery has advantages over the one referred to in that each five stamps can be independently hung up (without stopping or in any way interfering with the other), which is often desirable for economy, in case of insufficient quantity of ore, shortage of water, or in case of repairs.

General detail specification shown on following page.

General Specification of a Ten-stamp, Wet-crushing Battery.

(TWO INDEPENDENT CAM SHAFTS.)

[See illustration on opposite page.]

2 High mortars, of improved pattern, single discharge, planed on bottom and for screen frames.

2 Screen frames of soft pine, fitted to mortars.

2 Screens, steel wire or punched.

8 Gib-headed keys for screen frames.

2 Sheets of rubber, for mortar cushions.

10 Stamp dies.

10 Stamp shoes.

10 Stamp heads, bored for stems.

10 Stems of refined iron or mild steel, both ends tapered.

10 Tappets, with wrought-iron gibs, two steel keys.

10 Union self-fastening cams, 5 right and 5 left hand, double armed.

2 Cam shafts of hammered iron or steel, turned and marked for each cam.

2 Narrow cam shaft boxes, bored and planed on bottom and back.

1 Wide cam shaft box, bored and planed on bottom and back.

4 Wrought-iron cam shaft collars, with steel set screws.

2 Pairs cast-iron sleeve flanges, 36″ diameter, with wood pulleys 72″x14″, built up of clear, seasoned pine, and fitted to flanges, which are bored and keyed to the shaft.

2 Upper and two lower hardwood guides, bored for stems, with proper bolts.

2 W. I. jack shafts.

4 C. I. jack shaft bearings, with lag screws.

10 Latch sockets for fingers, lined with leather.

10 Wood fingers, mounted complete.

1 Set of water pipes, valves and fittings, as required.

All bolts, nuts, rods and washers for a 10-stamp battery frame, complete.

1 Steel key for loosening shoes and stamp heads.

Approximate Weight of Stamp Batteries.

Weight of iron work, including wood pulley and guides for standard batteries, complete, as specified on pages 54 and 56.

5	Stamps,	750	lbs.	each	12,500 lbs.
10	"	750	"	"	25,000 "
5	"	800	"	"	14,000 "
10	"	800	"	"	28,000 "
5	"	850	"	"	14,500 "
10	"	850	"	"	29,000 "
5	"	900	"	"	15,000 "
10	"	900	"	"	30,000 "
5	"	950	"	"	15,500 "
10	"	950	"	"	31,000 "
5	"	1,000	"	"	16,000 "
10	"	1,000	"	"	32,000 "
5	"	1,050	"	"	16,500 "
10	"	1,050	"	"	33,000 "
5	"	1,100	"	"	17,000 "
10	"	1,100	"	"	34,000 "
5	"	1,200	"	"	18,000 "
10	"	1,200	"	"	36,000 "
5	"	1,300	"	"	19,000 "
10	"	1,300	"	"	38,000 "
5	"	1,350	"	"	19,500 "
10	"	1,350	"	"	39,000 "

Wood Frames for Batteries.

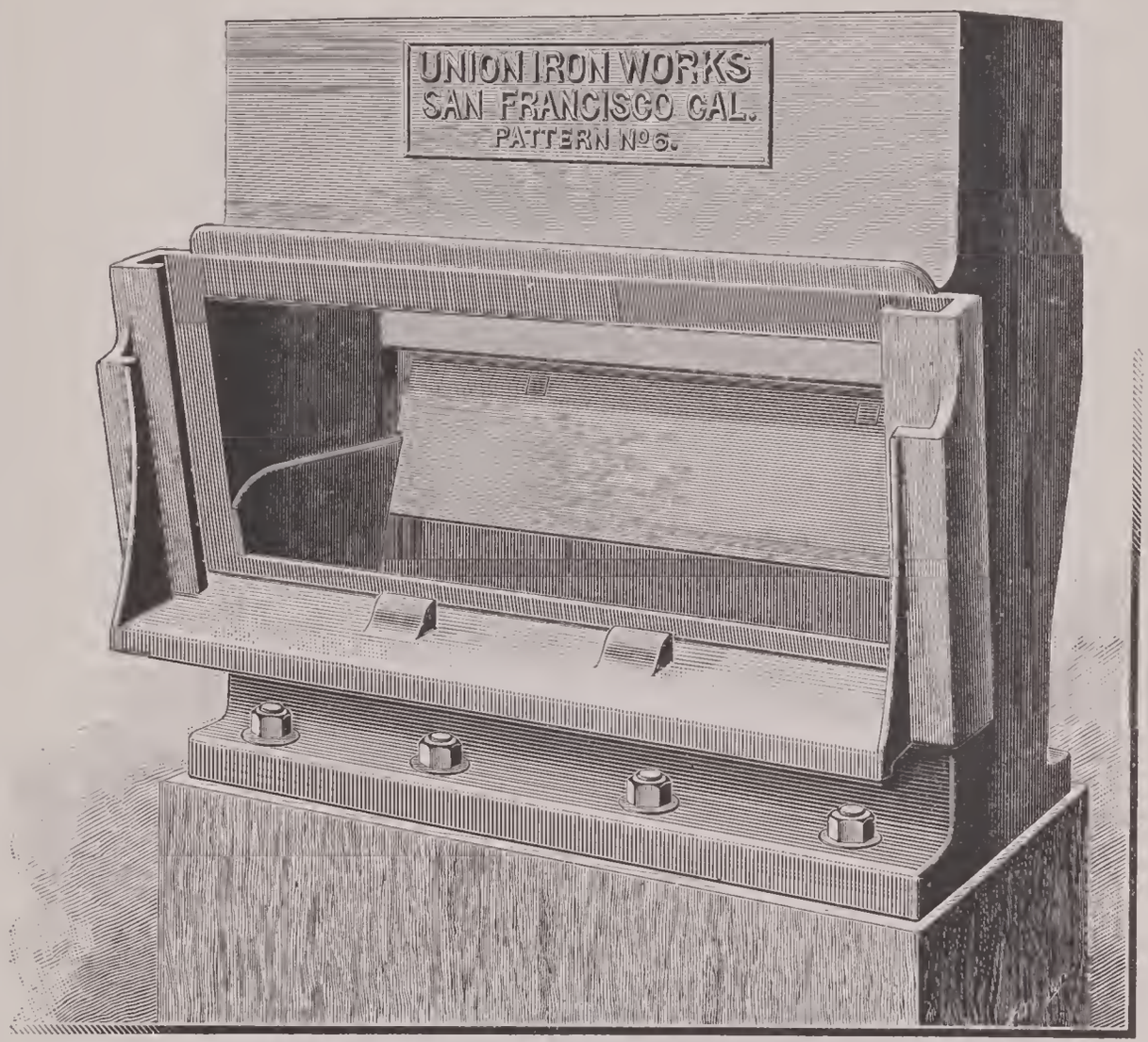
We supply complete wooden battery frames when circumstances make it impossible or too expensive to obtain timber near the millsite. The frames built by us are always set up in our shops, and when knocked down are marked so as to be easily put together again.

Weights in following table are approximate for standard frames.

850 OR 1,000 POUND STAMPS.

3	stamps,	with	mortar block,	4,500	lbs.,	Price	.....
3	"	without	" "	2,000	"	"	.....
5	"	with	" "	14,000	"	"	.....
5	"	without	" "	8,000	"	"	.....
10	"	with	" "	26,500	"	"	.....
10	"	without	" "	14,500	"	"	.....

Further details given upon application.



Gold Mortar.

STANDARD CALIFORNIA PATTERN.

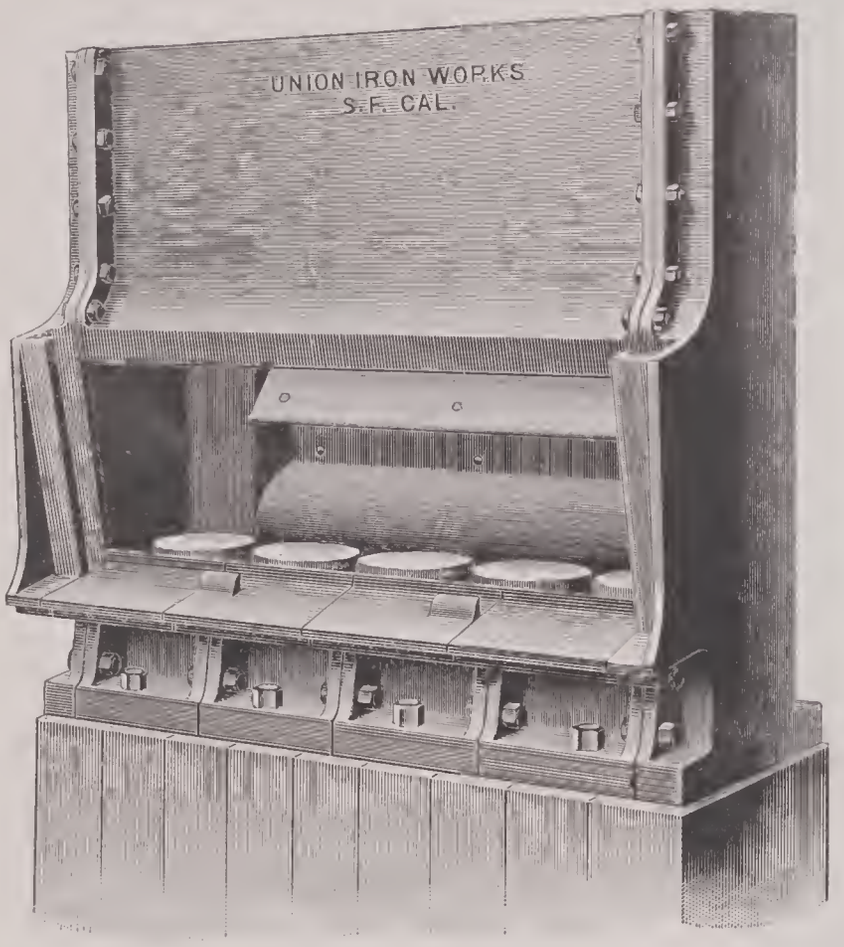
The capacity and efficiency of a mill is largely dependent on the design and construction of the mortars, and it has taken many years of patient experiment by mining men to determine the best proportions to use.

The mortar illustrated above is one of the most popular designs we have produced, and in its proportions and construction represents the best California practice, and in all the minor details is thoroughly up to date.

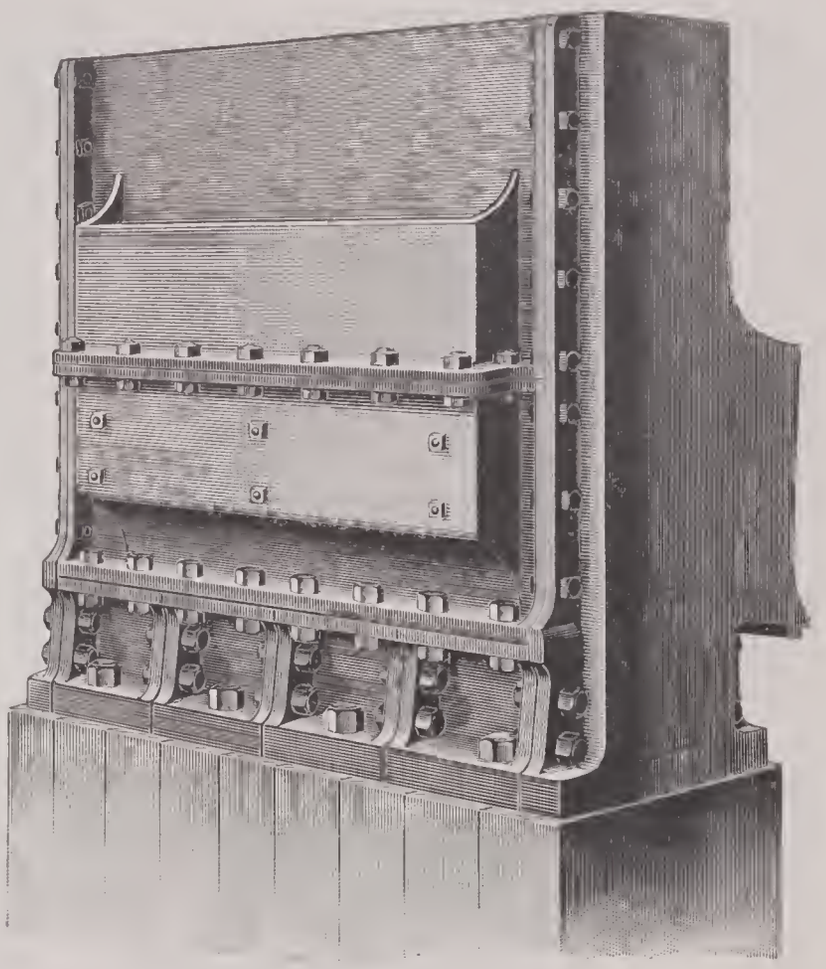
This mortar is suitable for 1,000-pound stamps, is provided with cast-iron lining plates, and provision is made for one copper plate in front only. Complete with liners, it weighs about 7,000 pounds.

Further information given upon application.

FRONT VIEW.



BACK VIEW.



Cast-iron Sectional Mortar.

300-pound Sections. For Mule-back Transportation.

Sectional Machinery

—FOR—

Mule-back Transportation.

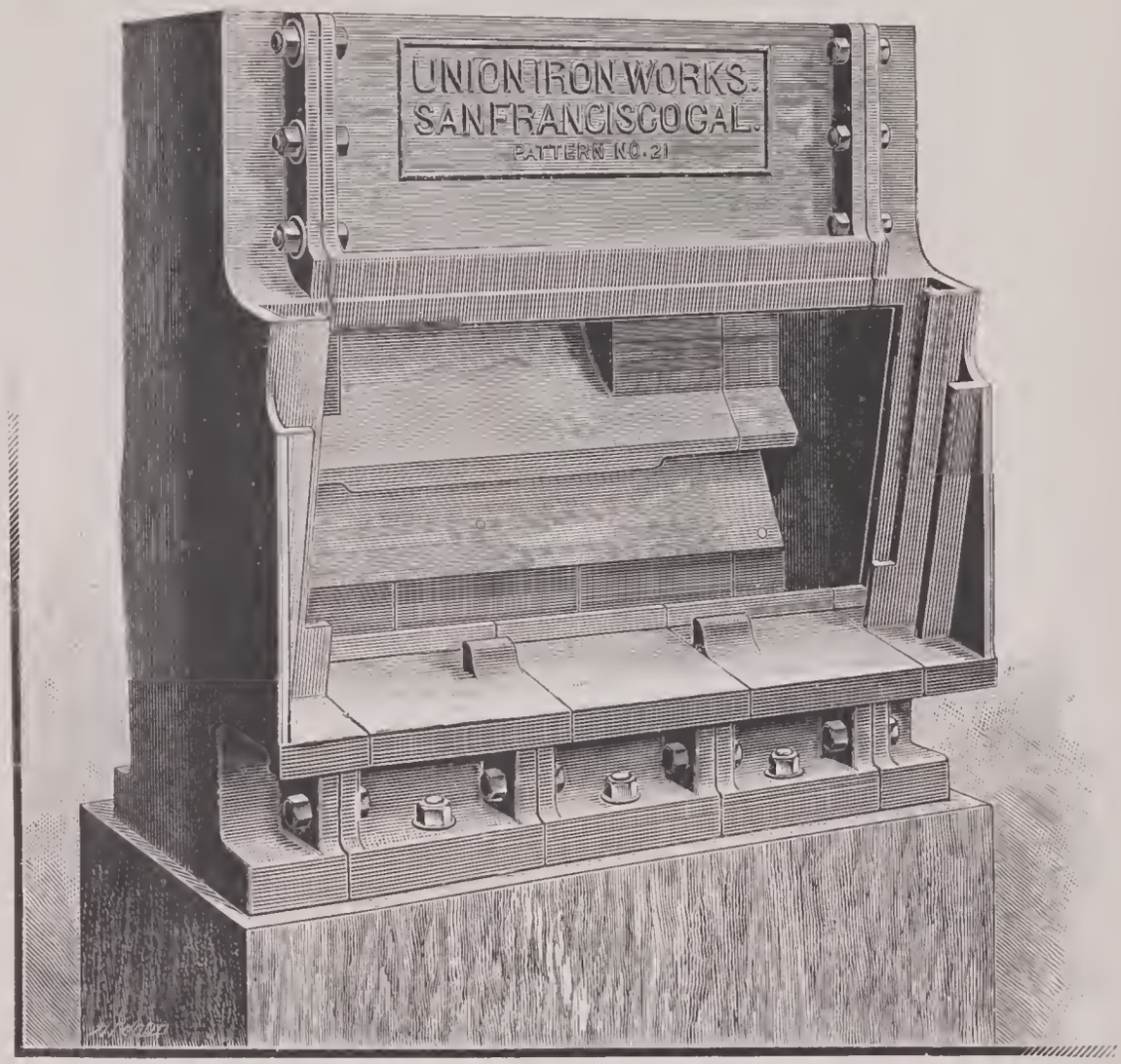
We manufacture Sectional Machinery of all kinds to be transported on mule-back. Our experience in this class of machinery has been varied and extensive, and we are prepared to furnish plants of any magnitude.

The illustration on the opposite page shows a Sectional Mortar made entirely of cast iron. The sections are made not to exceed 300 pounds in weight, which permits them to be packed on mule-back over the roughest trails.

All sections are planed and fitted to each other, and bound together by perfectly fitted bolts, as is clearly shown in the engraving.

This mortar, when properly bolted together, is as strong and equally efficient as one cast solid.

Information regarding sectional machinery of any type furnished upon application.



Sectional Mortar.

(1,000-POUND SECTIONS.)

The mortar illustrated above is made in 1,000-pound sections, is very strong and substantial, and is suitable for 1,100-pound stamps. No lining plates are employed.

The sections are held together by a large number of heavy fitted bolts, with spring-lock washers under the nuts, making it as rigid and efficient as a solid mortar. Provision is made for a copper plate in both front and back, and independent wedges hold the chuck block in place, so that the screen frame may be removed without disturbing it.

Weight of mortar, about 6,500 pounds.

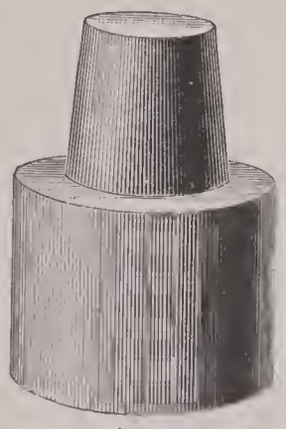


Fig. 1.

Shoes.

Fig. 1 illustrates the common form of a Stamp Shoe. It is cylindrical with a taper shank, and is cast of steel or hard white iron.

Dies.

Fig. 2 illustrates the Die. The body, like the shoe, is cylindrical, and of a corresponding diameter, while the base is a rectangular flange with corners cut off. Shoes and dies are made either of steel or white iron.

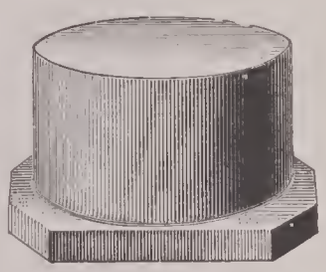


Fig. 2.

Gib Tappets.

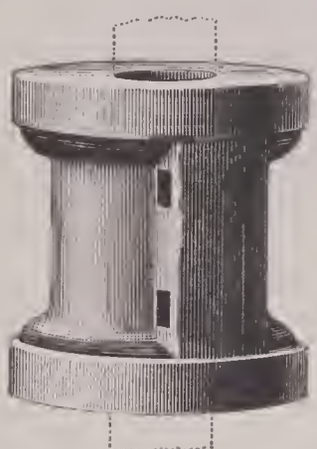


Fig. 3.

The Tappet, made of cast steel or iron, is secured to the upper part of the stem, and forms a projection under which the cam catches and lifts the stamp. Fig. 3 is a Tappet with two keys only. We make them with two or three keys, as may be required. Both ends are faced and counterbored, so that they can be reversed on the stem and both ends used before it is worn out. It is secured to the stem by a wrought-iron gib fitting the curvature of the stem, and held against it by the keys in the side of the Tappet.

Stamp Heads.

The Stamp Head, Socket or Boss, as they are sometimes called, is shown in Fig. 4. It is cylindrical, and is made of cast steel or the toughest cast iron, sometimes strengthened by wrought-iron bands shrunk on both ends. It is cast with two conical sockets, one in the top for the stem, which is always bored to a standard taper, and one in the bottom to receive the shank of the shoe. Keyways are cast through the stamp head at the bottom of each socket for the purpose of driving out the shoe or stem.

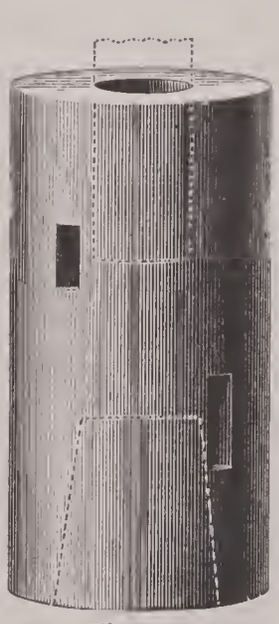


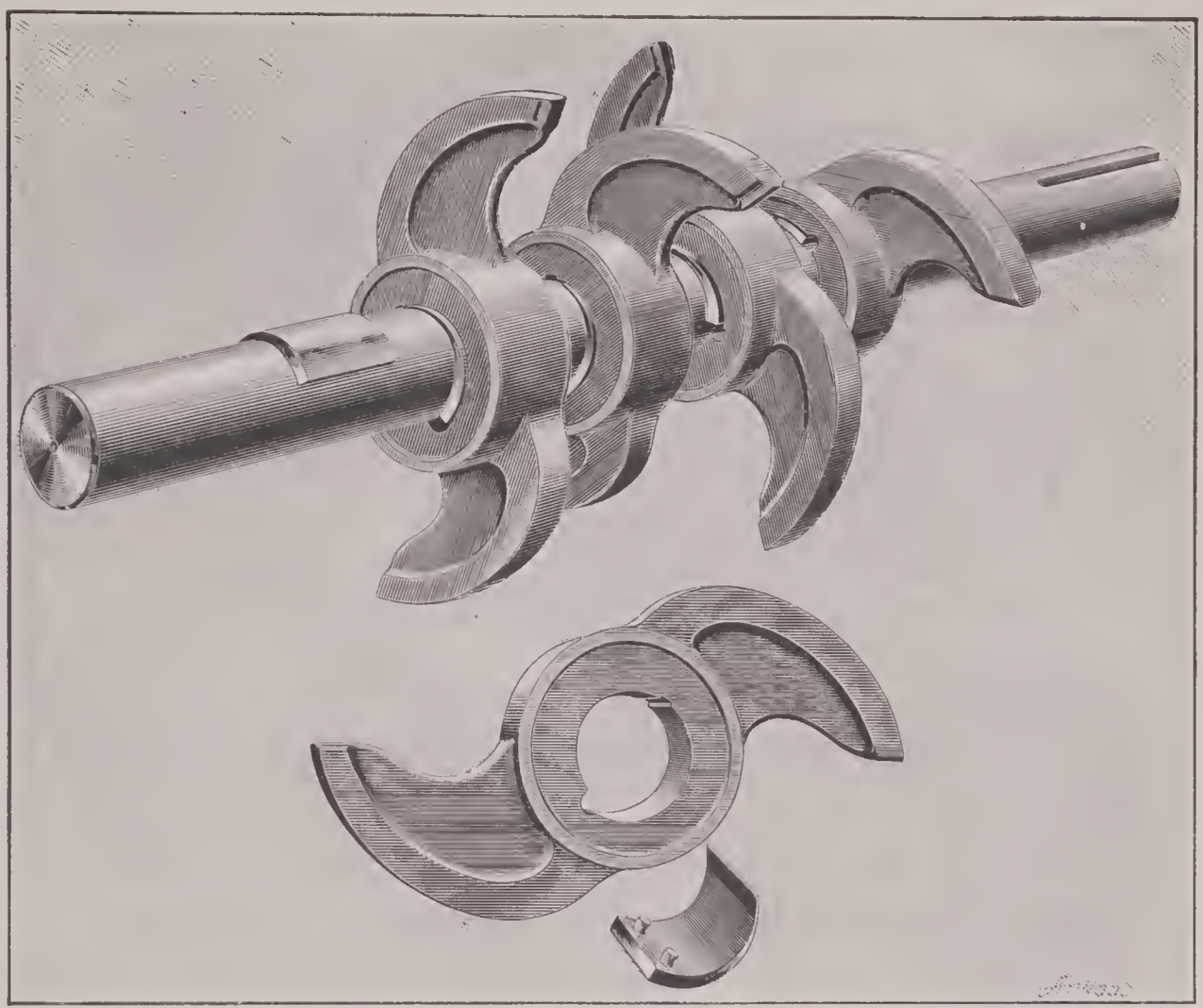
Fig. 4.

Fig. 1. Fig. 2.

Hammered Tool=steel Shoes and Dies.

The illustration above shows a Stamp Shoe and Die, forged from a special grade of tool steel. Fig. 1 shows them before using and Fig. 2 worn out. They give the best of satisfaction, will not chip or cup, wear about three times as long as white iron, and cost only about twice as much.

The density of these shoes and dies is much greater than cast steel, as the process of forging renders them free from air spaces or imperfections, and wherever tried in competition with cast steel they have shown an excess of wear of from 15 to 20 per cent.



The Union Improved Self-fastening Cam.

(BLANTON TYPE.)

The annoyance caused by loose cam keys, and the serious loss of time that always attends the removal or replacement of cams of the ordinary type is entirely avoided by the use of the Union Improved Self-fastening Cam, which grips the shaft by friction, and responds to heavier work by tightening its grip.

The construction is exceedingly simple, as shown by the illustration above. The cam is bored out so as to fit the shaft for about one-half of its circumference, the other side being fitted to receive a curved wedge (somewhat wider than the cam), which is bored on the inside to fit the shaft, and turned on the outside, eccentric to its bore. This curved wedge is less than a half circle—so that the cam can turn about three-quarters of an inch on the eccentric (or outside) face of the wedge. The wedge is provided on its inner face with two short pins (or dowels), which fit into shallow holes in the shaft, drilled with reference to the position the cam is to occupy. When the curved wedge is in its proper position on the shaft the cam is slipped over it so as to come to its place, and by turning it sharply back upon the wedge it is firmly fixed, the work of lifting the stamp merely serving to clamp it more firmly to the shaft.

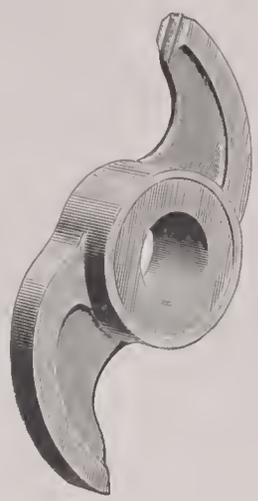
A light blow with a sledge on the point of the cam, in the direction that it revolves, will instantly loosen it, and the whole set of cams may be removed or replaced in a few minutes. The dowels serve to keep the cam in place while it is being tightened, but there is no strain on them, as the grip on the shaft is entirely by friction.

This method of securing cams has received the indorsement of all mill men, and is recognized as one of the most important improvements made in the stamp battery during the past few years. It is rapidly superseding all former methods, it has given the best of satisfaction, is perfectly reliable and the additional cost is not great.

Further particulars, prices, etc., given upon application.

LEFT HAND.

Fig. 1.



RIGHT HAND.

Fig. 2.

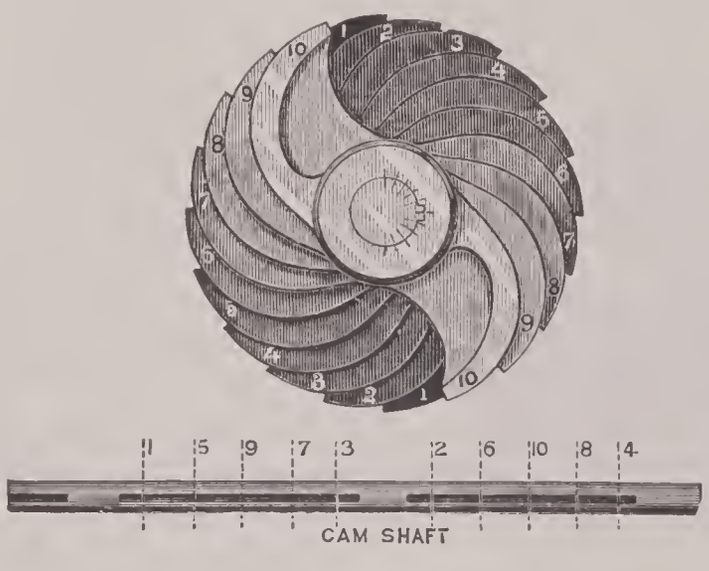
Cams.

Cams are made with double arms, as they give the least friction on cam-shaft and require the least power. The proper curve of the cam is a modified involute of a circle, the radius of which is equal to the horizontal distance between the center of cam-shaft and the center of stamp stem. The modification of this curve consists in giving a sharper curvature than the involute, near the end. This form of cam takes the weight of the stamp at the least practicable distance from the center of cam-shaft, and on account of the peculiar curve leaves the tappet without any dragging. The outer end is shaped to conform to the edge of the tappet.

Cams are made either of selected iron or of steel—the former may be banded around the hub to insure additional strength. According to the position of this hub, when located on the shaft, cams are termed "left-hand" cams or "right-hand" cams—see above illustrations.

In ordering this distinction should *always* be noted and mentioned.

Send for our order blanks for ordering Shoes, Dies, Cams, Tappets, etc.



Order of Drop.

The respective positions of cams when keyed to the cam-shaft, or the order of drop of the stamp, is a matter which admits of much diversity in practice. It is desirable to drop the stamps in such rotation as to insure an even distribution of the pulp on the several dies in the mortar. For five-stamp batteries the order 1, 4, 2, 5, 3 (*i. e.*, first stamp drops first, this is followed by No. 4, that by No. 2, and so on) seems to be the best to fulfill the above requirements. The order 1, 5, 2, 4, 3 is also extensively adopted. Our cut shows the order of drop for a ten-stamp battery to be 1, 5, 9, 7, 3, 2, 6, 10, 8, 4, which gives a good splash and satisfactory results in other respects.

Cam-shaft Boxes.

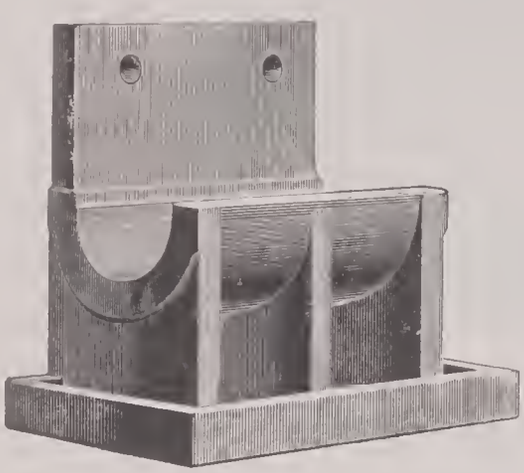


Fig. 1.

The illustration herewith (Fig. 1) shows the most improved type of single open Cam-shaft Boxes, most commonly employed. Caps are not furnished, as they are wholly unnecessary, the entire thrust being downward. They are generally made solid, the bearing being bored out; but can, however, be babbitted if desired. The boxes are securely held to the battery posts by four bolts, and are provided with oil cellars around the base (see engraving) for catching any waste oil.

Fig. 2 is representative of the same type of Cam-shaft Boxes, and differs only in being wider and made for two shafts, placed end to end, as is necessary in stamp batteries with independent cam-shafts (see illustration on page 56). They are held to the battery posts by six bolts.

In ordering give exact diameter of shaft and length of bearing required.

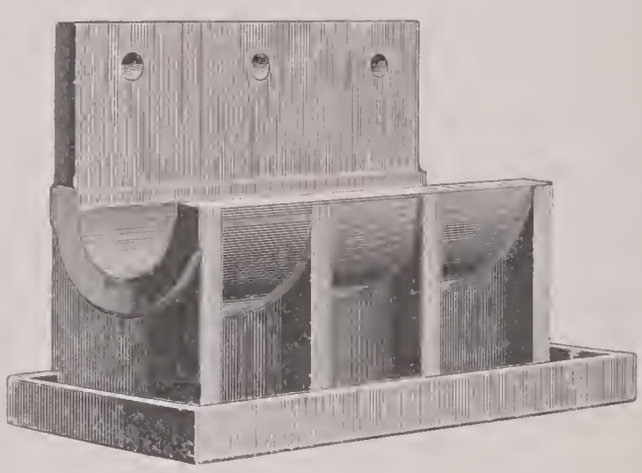
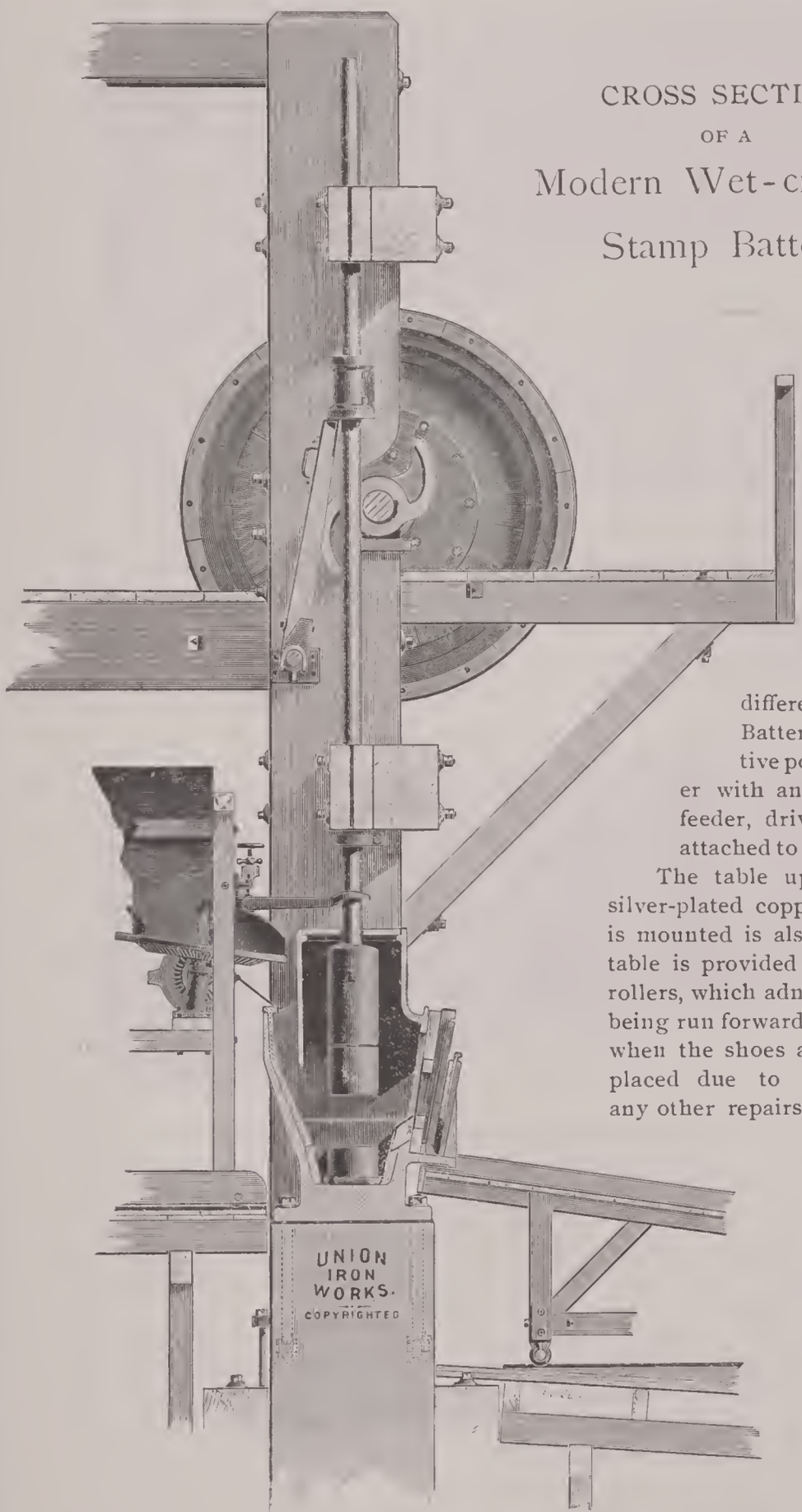


Fig. 2.



CROSS SECTION
OF A
Modern Wet-crushing Stamp Battery.

The illustration herewith is a cross-section of a Modern Wet-crushing Stamp Battery, as usually employed in California for working gold ores. It shows all the different parts of the Battery in their relative positions, together with an automatic ore feeder, driven by a collar attached to the stamp stem.

The table upon which the silver-plated copper apron plate is mounted is also shown. This table is provided with casters or rollers, which admit of the plates being run forward out of the way, when the shoes and dies are replaced due to wear, or when any other repairs or changes are necessary.

This illustration will be found valuable to those ordering duplicate parts for repairs, as by reference to it all orders can be intelligently filled.

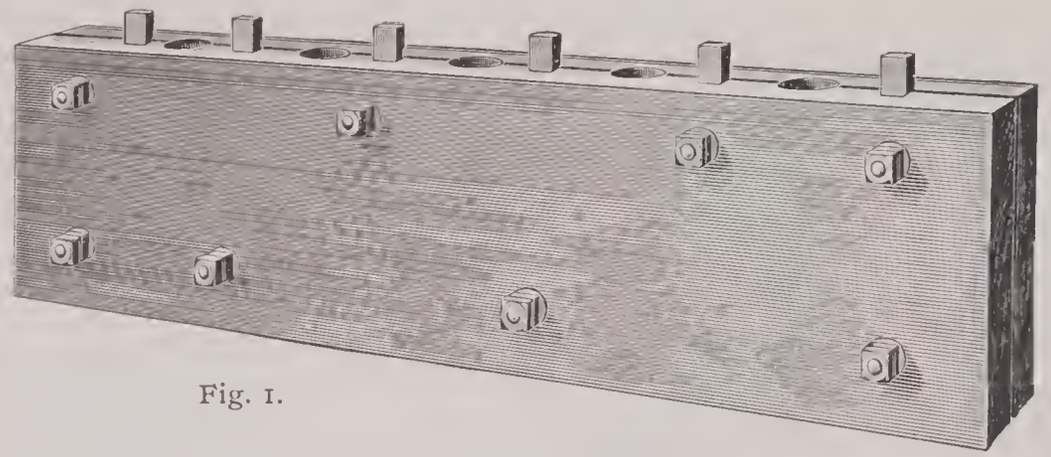


Fig. 1.

Plain Hardwood Battery Guide.

The guide illustrated above (Fig. 1) is the type most commonly employed.

It is made of hardwood in two sections, fastened to the guide girt by means of collar bolts, so as to allow the removal of the front half without disturbing the back. Gib-headed parting pieces or separators are provided between the guides, which can be planed down from time to time, thus taking up the clearance and insuring a perfect bearing for the stamp stem.

Upper guide—Weight, 160 pounds.	Price, $20.00
Lower guide—Weight, 170 pounds.	Price, $22.00

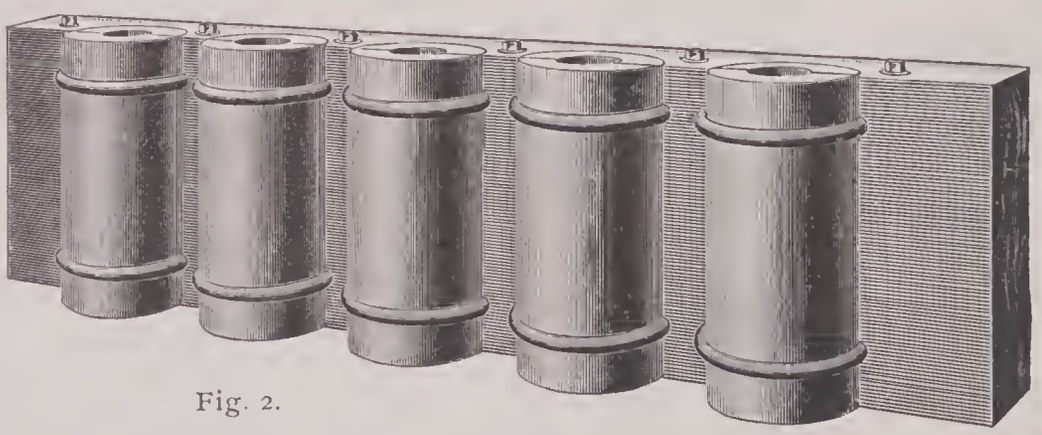


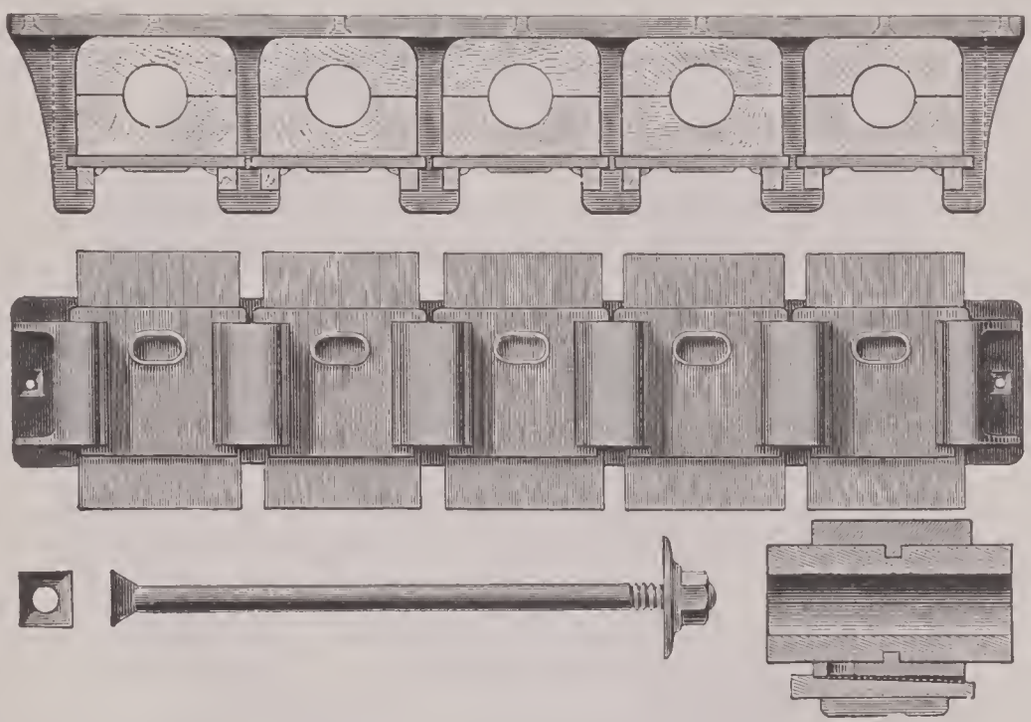
Fig. 2.

The Wood Sectional Battery Guide.

The battery guide illustrated herewith (Fig. 2) is superior in some respects to the one shown above, as each stamp has its independent wood filling or guide block, permitting the hanging up of any single stamp (in time of repairs or adjustment) without interfering with the others of the battery.

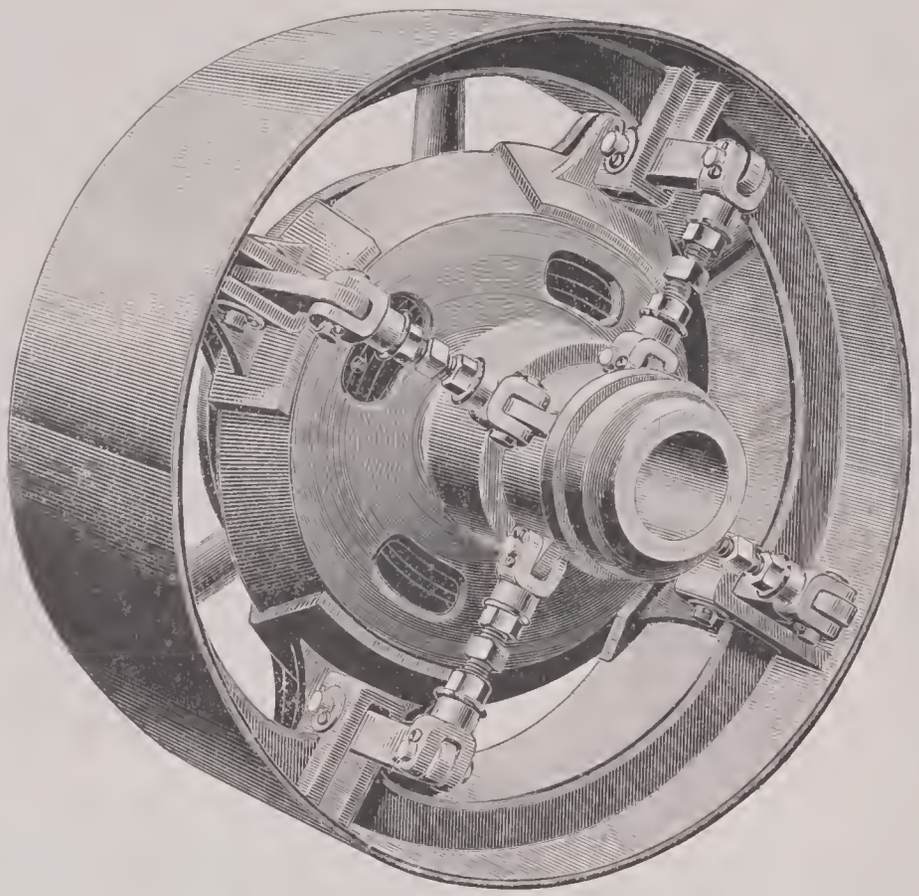
The backing is made of hardwood, to which are fastened the guide blocks, as shown in the engraving. It is reinforced by six lateral bolts to prevent splitting or warping. The Norway iron U bolts serve two purposes, they hold the wood fillings or guide blocks (made in halves) firmly in place, and also tie the guide to the girt.

Upper guide—Weight, 250 pounds.	Price, $30.00
Lower guide—Weight, 300 pounds.	Price, $32.00



The Union Battery Guide.

The Union Battery Guide consists of a solid cast-iron chair or stool which is bolted against the battery guide beam, with countersunk head bolts, as shown in the illustration. The wooden guide blocks are held in place by a rib cast horizontally on the stool, as shown in section, over which the wooden guide block is fitted, then the cap is slipped into place and rests on the stool by lugs cast on for that purpose, and is kept up against the wooden guide block with wooden keys inserted on the back of it. As the guide blocks wear, the wooden keys are driven down. Every guide is independent of the other, and any length of wood may be used. We claim perfect and independent adjustment. Any stem may be taken out of place or new guide blocks put in without interfering with the others. The guide blocks can be renewed at a very small cost of material and time.



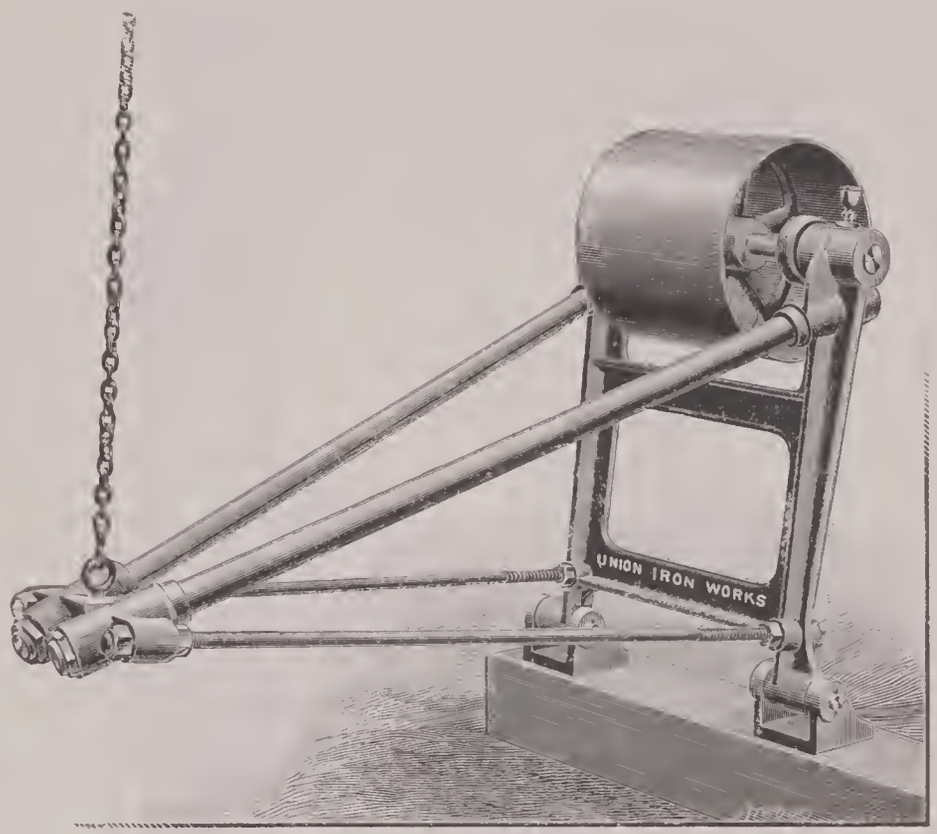
Friction Clutch Pulley.

(GIBSON PATENT.)

The above illustration shows a Friction Clutch Pulley so constructed that when the clutch is thrown out the pulley rests on a stationary sleeve and not on the shaft, as in other designs, thus relieving the shaft and pulley from wear and friction when the pulley is not running.

This clutch is very powerful and reliable, and is particularly adapted for use on battery line shafts, as it dispenses with belt-tighteners, and allows the battery to be cut out without affecting the rest of the mill. This pulley can be built in all sizes.

Further information furnished upon application.



Standard Belt Tightener.

(TRIANGULAR FRAME.)

The Swinging Belt Tightener illustrated above is our standard and latest design, and is, in almost all cases, preferable to the old-style sliding tightener, on account of its stiffness, ease of operation, and the facility with which it may be placed in position.

PRICE LIST, SIZES AND WEIGHTS.

Size of Pulley in inches.	Diameter of shaft.	Weight in pounds.	Price.
16 x 6	1½	400	$50.00
16 x 8	1½	450	52.00
16 x 10	1½	500	54 00
16 x 12	2	550	56.00
16 x 14	2	575	58.00
16 x 16	2	600	60.00

DIRECT.

GEARED.

Weston's Patent Differential Pulley Blocks.

Number.		Capacity in tons.	Will hoist in feet.	Weight complete in pounds.	Price.
Direct Blocks	1	¼	6	22	$ 14.50
" "	2	½	7	30	16.50
" "	3	1	8	51	22.00
" "	4	1½	8½	81	27.50
" "	5	2	9	122	33.00
Geared Blocks	6	3	10	159	66.00
" "	7	4	11	257	82.00
" "	8	5	12	324	99.00
" "	9	6	13	493	132.00
" "	10	8	14	735	176.00
" "	11	10	16	1,054	235.00

Fig. 1.

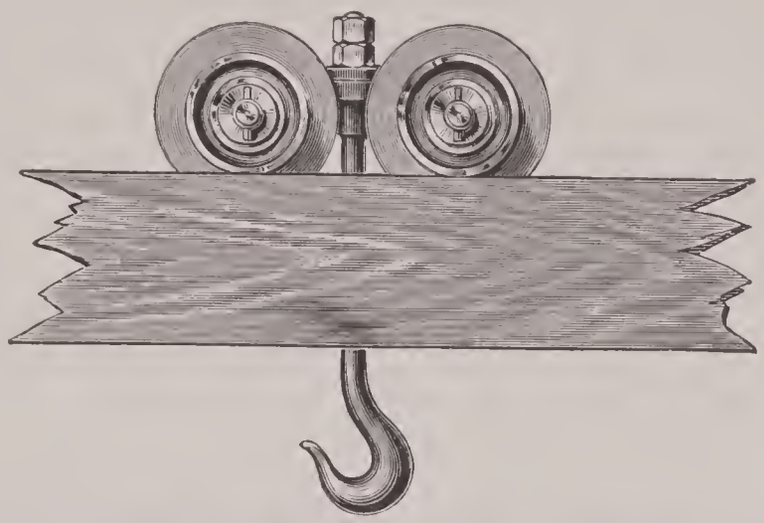
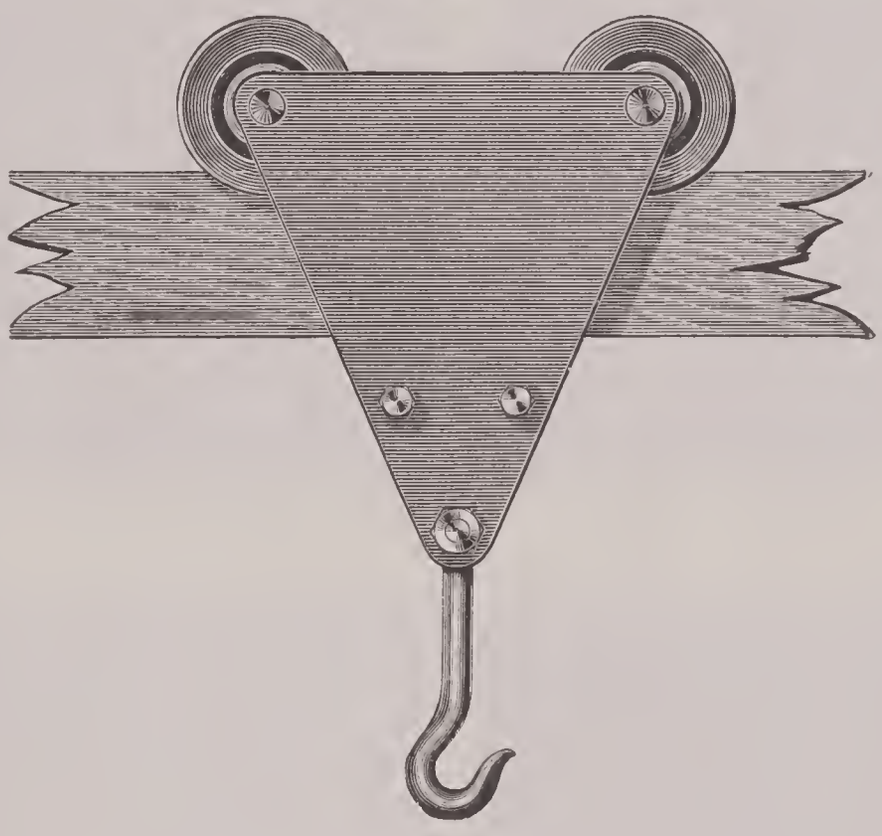


Fig. 2.



Overhead Crabs.

The illustrations above show our Overhead "Crabs," sometimes called "Crawls," used in connection with differential pulley blocks. They are essential in every complete mill for setting tappets, changing stems, etc. Iron-mounted track timbers are provided and secured to the roof in such a manner that they can traverse the entire length of the battery, pans and settlers, or other heavy parts of machinery requiring frequent handling. They are very convenient and save much time and labor.

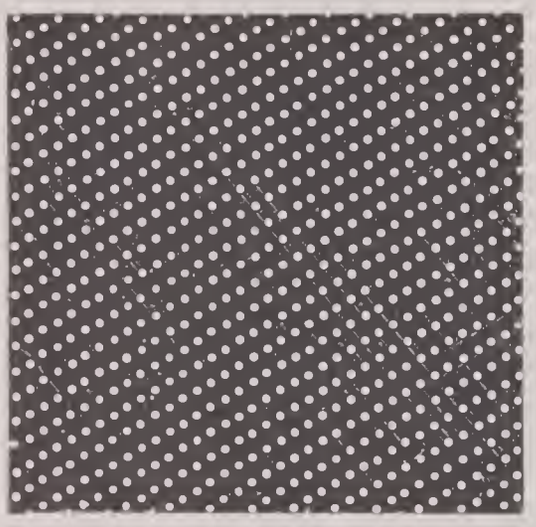
Fig. 1 illustrates a double rail traveling crab, which is the best and cheapest form, and the one most commonly used. It admits of the hook turning in any direction.

Fig. 2 illustrates a single rail traveling crab, which is more expensive than the above, yet sometimes it is preferable to use this form.

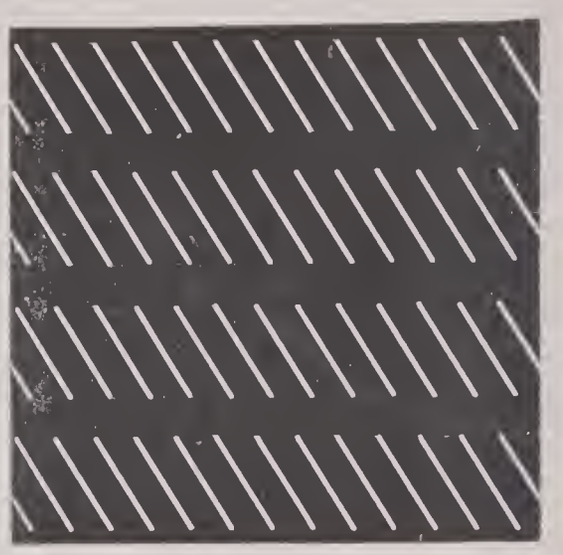
Fig. 1, weight 85 lbs . . . . . Price $10.00
Fig. 2, weight 105 lbs . . . . . Price $15 00

Battery Screens.

The diagrams below show the standard forms of Punched Screens. The size is governed by the needle gauge, the apertures being wide enough for a needle of corresponding number to pass through. Each kind of Screen is made with apertures varying from No. 1 to No. 10.

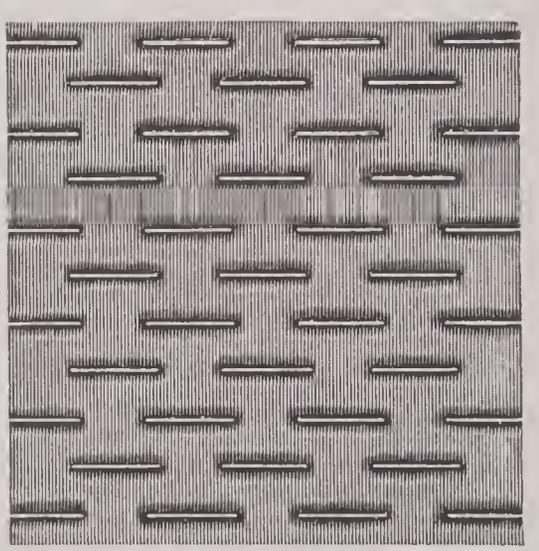


NEEDLE PUNCHED.



DIAGONAL SLOT.

STRAIGHT SLOT.



BURR SLOT.

Battery Screens are made by the Union Iron Works as designated above, and in ordering be particular to state kind of apertures and number of gauge required.

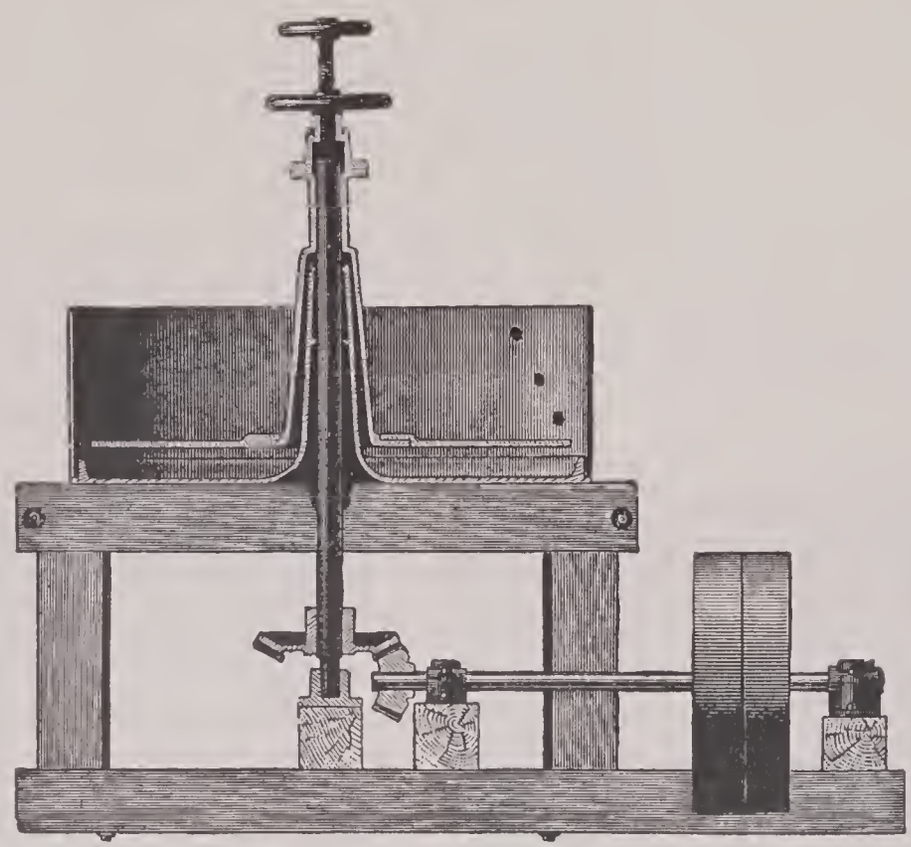
Battery Screens.

In the table given below will be found sizes, prices, etc., of the three different kinds of Battery Screens usually employed, viz. Russia iron, brass or steel wire, and tin.

We have a complete plant of machinery for the manufacture of these screens, and can usually fill orders for standard sizes from stock. Our facilities are such, however, that little or no delay will be experienced on any orders requiring special sizes.

PRICE LIST, ETC.

Russia Iron Screens.			Wire Screens.			Tin Screens.	
No. of needle.	Width or diameter of orifice, inches.	Price per foot, round or slot punched.	Equivalent mesh.	Brass wire, price per foot.	Steel wire, price per foot.	Equivalent number.	Price per sheet, size 14 x 20 in.
1	.058	$0 60	12	$0.50	$0.27	.....	.....
2	.049	.60	14	.50	.27	2	.15
3	.042	.60	16	.50	.27	.....	.....
4	.035	.60	.18	.50	.27	.....	.....
5	.029	.60	.20	.50	.27	1	.18
6	.027	.60	.24	.50	.38	.....	.....
7	.024	.60	.30	.52	.56	0	.20
8	.023	.60	.35	.55	.56	.....	.....
9	.020	.70	.40	.57	.57	.....	.....
10	.018	.75	.50	.58	.59	.....	.....
11	.0165	.80	.55	.....	.....	.....	.....
12	.015	.85	.60	.60	.68	.....	.....



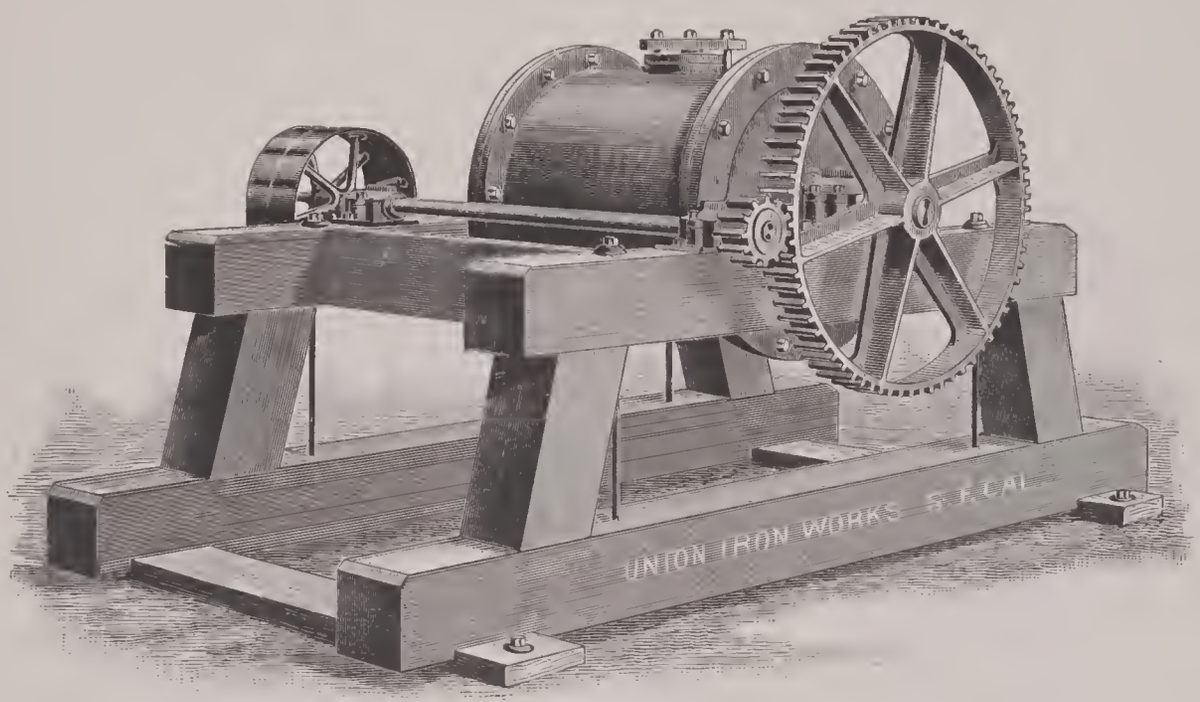
Clean-up Pan.

The above illustration shows a sectional view of a Clean-up Pan. In these the amalgam is worked with additional quicksilver, and the waste matter washed off before retorting. Wooden shoes are attached to the arms, and they are adjusted by means of the handwheels on top of the driving spindle, to bear on the bottom of pan or not, as desired, the motion being communicated through the bevel gear underneath to the spindle. We also build these pans heavier and with iron shoes for grinding, so they may be used in prospecting, and also for brightening small quantities of concentrates from blankets and sluices, that they may be taken up by the quicksilver.

PRICE LIST, WEIGHTS, ETC.

Size inside diameter.	Pulleys—Tight and loose.			Weight, pounds.	Price.
	Diameter.	Face.	Revolutions.		
18	10	3½	50	500	$ 80.00
24	12	4½	45	850	90.00
30	16	4½	40	1,150	120.00
36	24	6½	40	1,300	150.00
48	26	6½	40	1,800	200.00

When made sectional add 20 per cent to above prices.



Clean-up or Amalgam Barrel.

The above illustration shows a Clean-up or Amalgam Barrel. Crude amalgam containing much foreign matter is collected from the mortars and various parts of a mill at a "clean up," and is placed in an Amalgam or Clean-up Barrel, and there thoroughly worked and ground by cast-iron balls placed in the barrel, with the addition of quicksilver, which separates the amalgam from the impurities contained.

The cut represents a barrel mounted on a wooden frame. It is made of cast iron, and is cylindrical in form; the journals are cast on the heads, one is extended to carry the gear, as shown in the illustration, or for the attachment of a single or tight and loose pulley direct when no gearing is required. An opening with a suitable door is provided for the introduction of the material.

PRICE LIST, STANDARD SIZES, ETC.

Inside diam.	Length in inches.	Size of Pulleys for Driving Direct.		Weight in pounds.	Price.
		Diameter, inches.	Face, inches.		
12	18	20	3½	450	$ 50.00
16	18	24	4½	900	90.00
18	24	30	4½	1,250	135.00
20	30	36	6½	1,550	170.00
24	30	42	6½	2,000	240.00
30	48	48	8½	3,300	340.00

Gold Retorts.

Fig. 1.

Fig. 1, "Nevada" Gold Retort, is generally used in small gold mills. The cover and retort are faced to fit each other perfectly. The clamps are of wrought iron, and made strong and heavy. The pipe condenser is made so that its lower end is immersed in water while the retort rests in the fire.

Fig. 2 represents the style of Gold Retort as sometimes used in large gold mills. The amalgam trays are placed one above the other, the bottom one being curved to suit the bottom of the retort. The pipe condenser is run off to a tank, where the quicksilver is deposited.

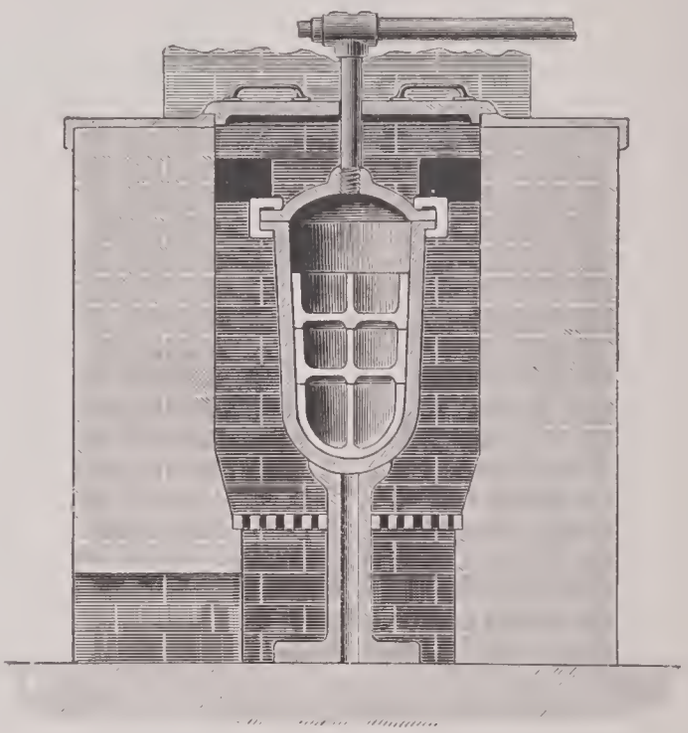


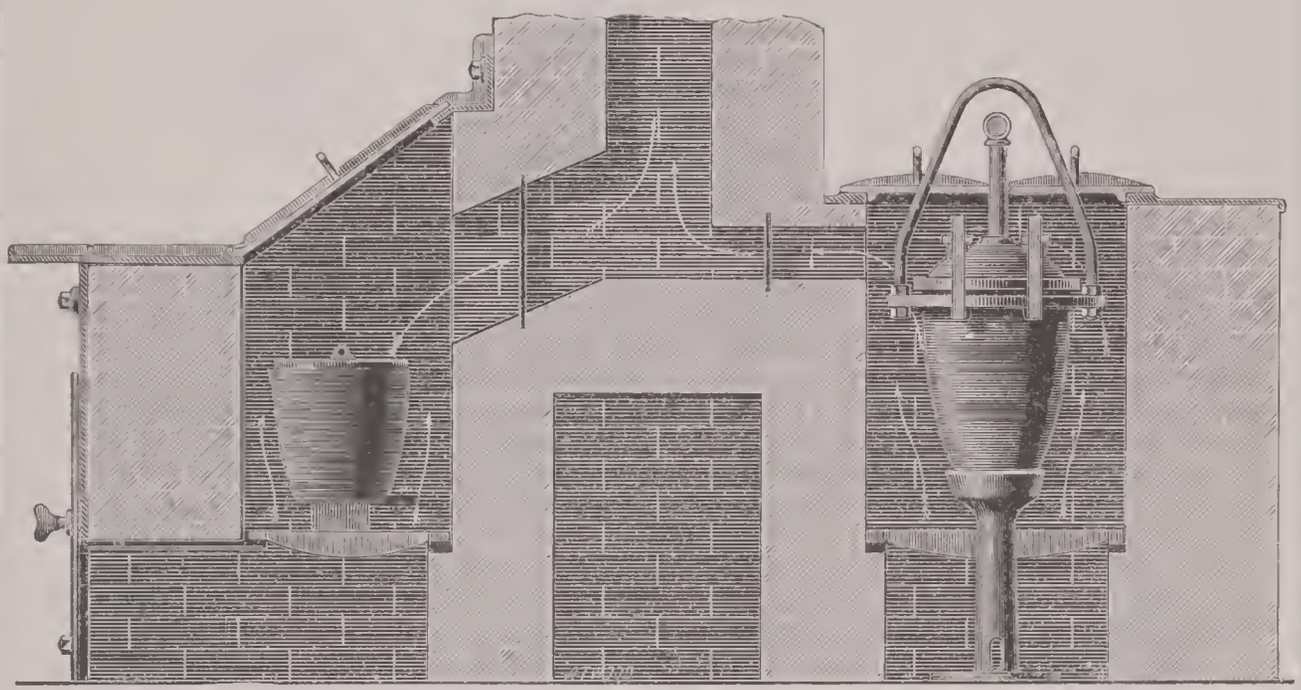
Fig. 2.

PRICE LIST, WEIGHTS, ETC.

Fig. 1. "Nevada" Retort. Oval top, with pipe.

Pints	1	2	3	4	5	6	10
Hold Amalgam, pounds	12½	25	38	50	63	75	125
Weight, pounds	10	15	18	25	31	44	65
Price, each	$4.50	$5.50	$7.00	$8.00	$9.00	$10.50	$12.00

Fig. 2. Retort. Weight.....lbs. Price.....



Retort and Bullion Furnace.

The illustration above shows a section of a Retort and Bullion Furnace, built together for convenience, and to use the same smoke-stack.

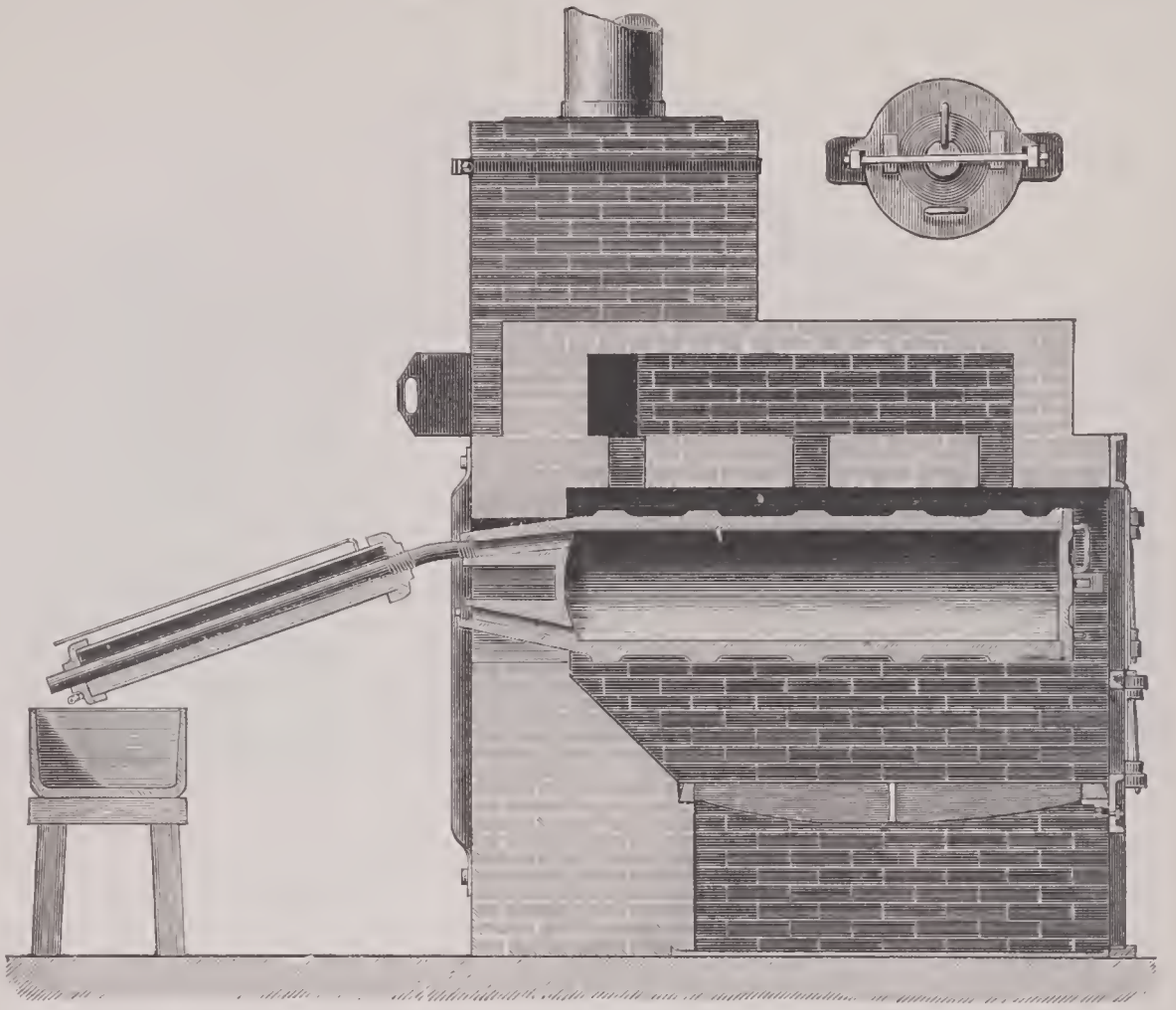
On the right of the engraving is shown the Retort Furnace, with retort, stand, fire box and cast-iron furnace top. The condenser is not shown, but is always furnished with every retort.

On the left of the engraving is shown the Bullion Melting Furnace, with black lead crucible, fire box, fire front and furnace cover. The spongy mass of metal taken from the retort is here melted and poured into suitable ingot molds.

We furnish all the iron work complete—grate bars, fire doors, buck stays and rods, base plate, smokestack and guy ropes, not including crucible, tongs or ingot molds.

Weight, 1,100 pounds. Price, $125.00.

We manufacture gold and silver retorts and furnaces of various designs and capacities, and furnish with the iron work complete plans for erecting.



Retort and Bullion Furnace.

The above illustration shows a Retort and Bullion Furnace. The retorts are usually made fourteen inches inside diameter. When the retort has become warped and one side burned from long contact with the fire, or if the neck becomes injured in any way, it can be turned over and the other neck used. There are lugs cast on the sides on each of the ribs shown, to support the retort in the brickwork. A cast-iron front is supplied, with grate bars, bearers, etc. The condenser is made of six-inch tubing with cast-iron heads, and fits over the pipe that carries off the fumes. It has water constantly circulating through it. On the opposite side, alongside the chimney, is placed the melting-back or bullion-melting furnace. This is not shown in the illustration, but we supply the furnace with grate bars, fire door, buck stays and tie rods, smokestack and base plate.

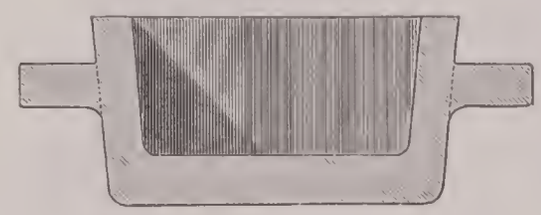
The bullion furnace is usually built in with the retort to save expense, for convenience, and to use the same smokestack.

PRICE LIST, WEIGHTS, ETC.

Size inside diameter.	Weight pounds.	Price.
10	3,000	$250.00
12	4,000	300.00
14	5,500	425 00

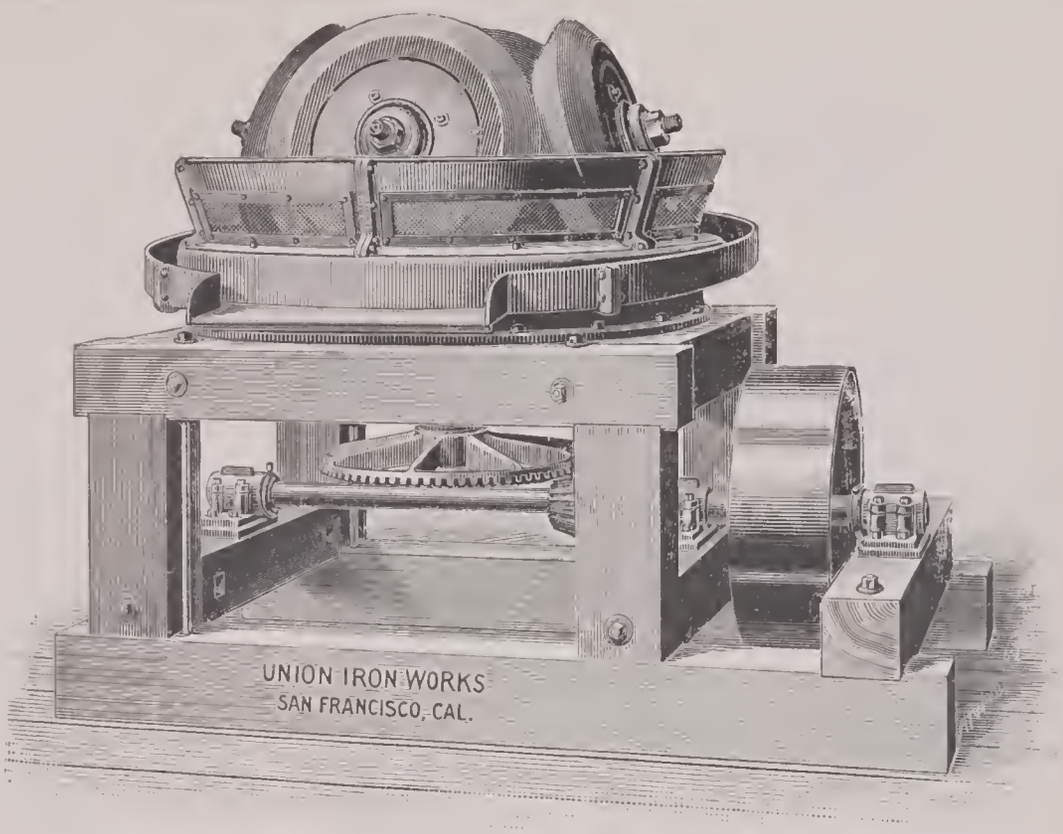
Further information furnished upon application.

Ingot Molds.



The above illustration shows our Ingot Molds, which are simple troughs made of cast iron. They have a slight taper, so that the ingot will readily fall out from them. The inside is smooth and true, with round corners. We have patterns for all sizes required.

Length.	Width.	Depth.	Capacity in ounces, gold.	Capacity in ounces, silver.	Weight.
1	5/8	1/2	4	2	1
1 1/2	1	3/4	10	5	1
2 1/4	1 1/8	1	25	12	1
3 3/8	1 3/8	1 1/8	50	25	3
3 1/2	2	2	95	50	6
4	2	1 3/4	100	56	7
4 1/4	2 1/4	2	136	76	9
4 1/2	2 1/2	2 1/4	180	100	10
5	2 1/2	2 1/4	244	134	10
5 1/8	2 3/4	2 1/4	250	140	10
5 1/2	2 5/8	2 3/4	295	166	11
5 1/2	3	2 3/4	365	200	12
5 3/4	3	2 3/4	375	208	13
6 1/2	3 1/4	3 1/4	550	300	15
6 3/4	3 1/2	3 1/4	620	340	19
7 1/2	3 1/2	3 1/4	730	400	28
8	3 3/4	3 1/2	910	500	35
9	3 3/4	3 1/2	1,015	600	36
9 1/2	4	3 1/2	1,285	700	40
9 1/2	4 1/2	3 1/2	1,448	800	41
10	4	4	1,470	800	42
10 1/2	4	4	1,650	900	55
11	4 1/2	4	1,830	1,000	65
11	4 1/2	4 1/2	2,200	1,200	72
11 1/2	5	5	2,750	1,500	76
12	5 1/2	5 1/2	2,900	1,570	85
13	6 1/2	5	3 356	1,827	110
13	6 1/2	5 1/2	3,675	2,000	147



Union Roller Mill.

The illustration above shows the Union Roller Quartz Mill. It is entirely different in several essentials from the numerous types of so-called "Chilian" mills, and is the result of careful study of the many defects that exist in other mills of the roller type.

Experience has dictated many radical changes from the previous types, but all the good points of the old "Chilian" mill have been carefully retained in this, and one of the most objectionable features, the uneven wear of the tires and dies, entirely eliminated.

The rolls are driven by means of shafts or axles, pivoted to the driving head in such a manner that inside of certain limits the rolls are allowed free vertical movement, but are firmly held against any horizontal motion in relation to the driving head. The driving head is rotated by means of the vertical shaft receiving its power through gear and pinion located underneath, as shown in illustration.

The ore is fed into a revolving hopper carried on the driving head of the mill and does not enter the mill at any one point, but is evenly distributed all around the die between the rolls, of which there are four, four feet in diameter, of an aggregate weight of about 20,000 pounds. The rolls are cast hollow and can afterwards be filled with lead at the mine, thus increasing the weight.

The base plate carries an extension which is provided with screens for discharging pulp.

The rolls are perfectly adjustable, as is also the amount of pressure on the spherical grinding face; and the free vertical movement prevents the danger of damage if a hammer or piece of steel should get into the mill.

The mill is calculated to stand the hardest usage and to crush hard as well as soft ore. It is self-contained and has the advantage of economy of iron and power over other mills.

PRICE LISTS, WEIGHTS, ETC.

Size diameter, feet.	Capacity, tons.	Weight, pounds.	Price.
4	40	25,000	$2,000.00
6	25	40,000	4,000.00

Further information given upon application.

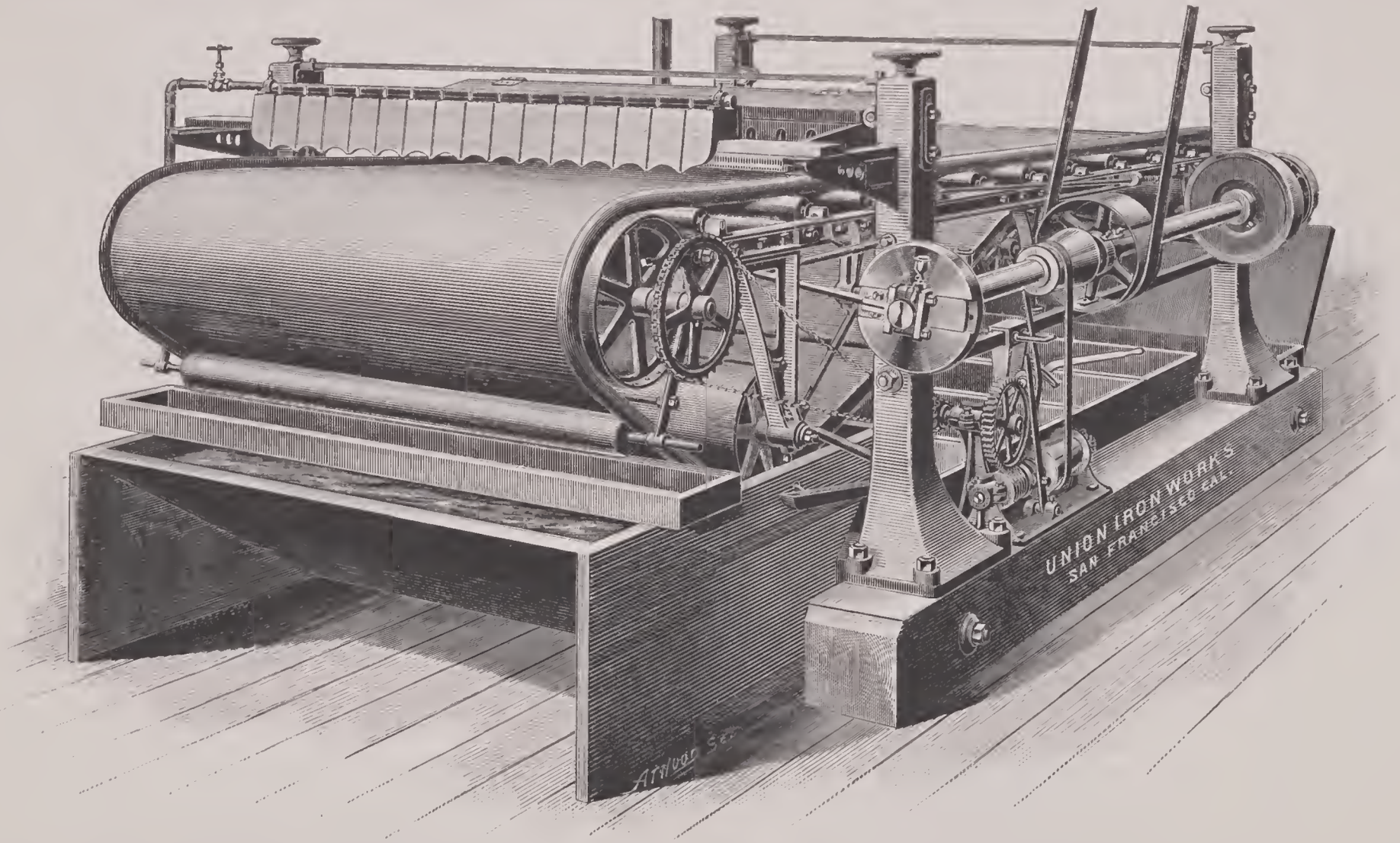
Union Improved Ore Concentrator.

No process connected with the reduction and treatment of ores commands as much attention as that of concentration. As is well known, the ores in many of our most prominent mines carry their value largely in the sulphurets, and, when large quantities or ores are being milled, close and economical concentration is a matter of the greatest importance, and the production of a simple and efficient automatic concentrating machine, capable of being adapted to the varying conditions and character of ores, has cost many thousands of dollars in experiments, extending over a wide field of practice.

The Union Improved Ore Concentrator, which we illustrate herewith, is the latest and most improved machine of this class now made. In it are embodied all that twenty years of practical experience with concentrating machinery has demonstrated as valuable, and we believe we are justified in offering it to the mining public as the best concentrator now made.

No radical innovations have been introduced into this machine. It is of the well-known Vanner type, with an endless traveling rubber belt, having a side shake or lateral motion. It possesses, however, means of adjustment that render the machine capable of being adapted to any character or condition of ores, a feature fully appreciated by those familiar with machines of this class. It is simple, durable and efficient, constructed entirely of iron and brass, and is complete and ready for erection as it leaves our works.

On pages 87 and 89 will be found a more complete and detailed description of this machine.



Four-foot Union Improved Ore Concentrator

WITH SULPHURET DISCHARGE.

[PATENTED].

Union Improved Ore Concentrator.

On the opposite page we illustrate a Four-foot Union Improved Ore Concentrator, set up in complete running order. The type of machine here shown is so well and generally known that a lengthy description is not necessary.

The machine consists of an inclined shaking frame or table, suspended by hangers or links from the four iron posts or columns shown. A side shake or lateral motion is imparted to the frame by means of steel connecting rods, attached to adjustable cranks, keyed to main driving shaft.

Upon the shaking frame is mounted or stretched an endless rubber belt, with raised or flanged edges, forming the bed or plane upon which the dressing of the ore is effected.

This belt or bed is caused to travel continuously up hill by rotating the head roll or drum, the power which is transmitted by means of a link-chain belt and sprocket wheels, driven from the worm and gear shown.

The travel of the belt is under full control, and can be regulated to any speed required.

The operation of the machine is as follows: The pulp or crushed ore from the battery is conveyed to the distributor located on top of the shaking frame above the belt. This distributor spreads the pulp evenly over the surface of the bed or belt, which is moving continuously up hill, or toward the head of the machine.

The side shake or lateral motion given the bed causes the sulphurets and valuable metallic portions of the ore to settle and lie upon the surface of the belt, and, as they pass up hill, or toward the head of the machine, they come under the water box, delivering clear water in fine streams upon the belt; and, as the pulp passes through these streams, the worthless or lighter portion of the ore is "winnowed" out or washed from the valuable portions, and passes down the belt into the tailing sluice.

The valuable portions of the ore, which still adhere to the belt, pass on over the head roll until they come in contact with the small wooden automatic discharge roller shown. Here the moisture, still clinging to the belt, forms a water cushion, which causes the concentrates to leave the belt and deposit themselves in the small box resting upon the water tank, into which the belt is depressed for the purpose of washing off any fine sulphurets that may have escaped the automatic discharge.

When the small box is filled with sulphurets, it is removed and another substituted, thus making the process of concentration continuous and automatic.

Six-foot Union Improved Ore Concentrator.

WITH SULPHURET DISCHARGE.

[PATENTED.]

Six-foot Concentrator.

The illustration on the opposite page shows the Six-foot Concentrator. It is similar in every respect to the four-foot machine, with the exception that it is provided with a six-foot belt, and is made proportionately heavier.

CAPACITIES.

No specific rating can be given to a concentrator as regards capacity, as the capacity depends largely upon the character of the ore to be treated, amount of sulphurets contained in the ore, their value, etc.

The bed of ore upon the belt should never be of such a depth as to require very heavy streams of water to be delivered from the water distributor box in order to cut through the pulp, as a heavy stream of water will "boil" the finer sulphurets, which have settled upon the belt, to the top of the ore bed, from whence they are carried off with the overflow. When this occurs, the concentrator is overloaded, and a smaller quantity of pulp is necessary to do perfect work. In a general way, however, it may be said that a four-foot machine will handle eight tons per day and a six-foot machine twelve tons per day.

When the ore is not very heavy in sulphurets and their value not high, one six-foot machine will handle the pulp from five stamps, but, when the ore is heavy in sulphurets and their value high, two four-foot machines should be employed for each five stamps, and in some instances two six-foot machines.

WEIGHTS, PRICES, ETC.

The Union Ore Concentrators, complete, boxed and ready for shipment, weigh:

Four-foot machine ..... 2,800 pounds.
Six-foot machine ..... 3,300 pounds.

The prices of the Union Ore Concentrators, boxed and placed free on board cars or steamer at San Francisco, are:

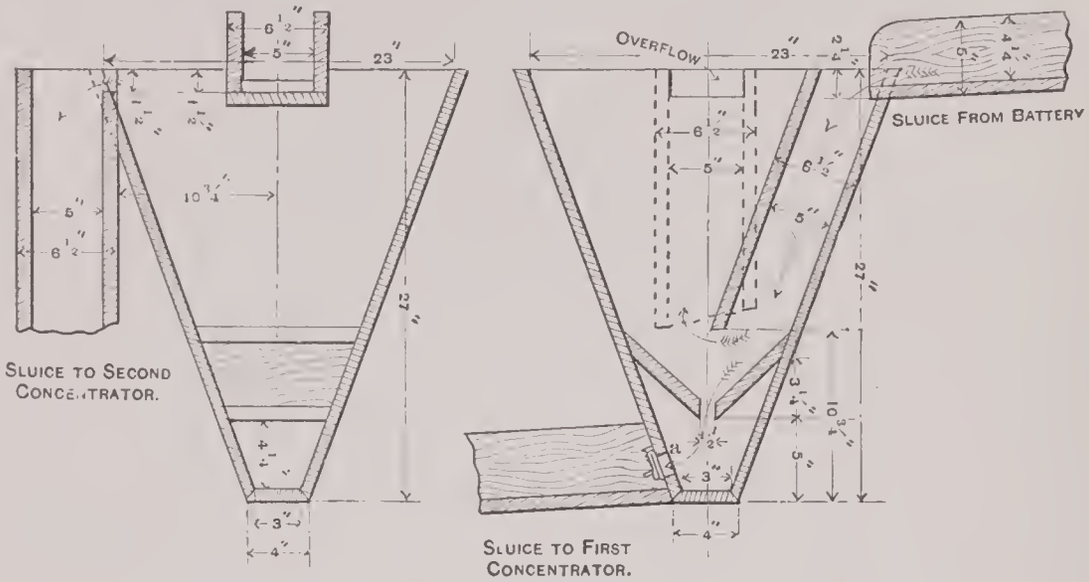
Four-foot machine .....$400.00 each.
Six-foot machine ..... 500.00 each.

These prices do not include overhead shafting, belting, head sulphuret box, or settling boxes under machine. If desired, we will furnish these at cost prices.

Head Sulphuret Box for Four-foot Concentrator . . 100 pounds, $7.00
Head Sulphuret Box for Six-foot Concentrator . . . 165 pounds, 8.00

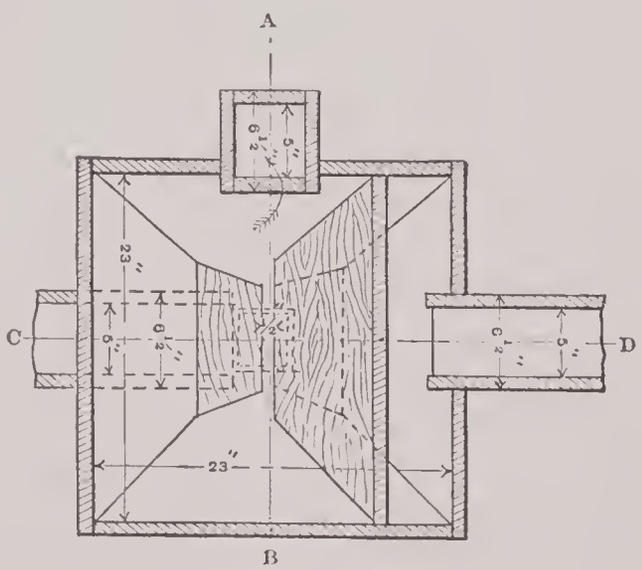
For further information send for our special Concentrator Catalogue.

SECTION A B. SECTION C D.



NOTE.—The gate usually employed, indicated by letter **a** above, is an ordinary molasses gate.

PLAN,



Pulp Sizer.

Sizing.

The process of concentration is practically weighing particles of ore of different specific gravity in water, and, to obtain the most perfect results from the process, the particles of ore should be as near the same size as possible.

Sizing is not generally employed, as it adds one more step to the process, and requires from two (2) to four (4) feet more grade, and, when in operation, more or less attendance. However, when the sulphurets are rich, and the ore has a tendency to slime, sizing should be employed, as it enables the concentrators to do closer and better work, as well as separating a large proportion of the slimes from the pulp, which can be delivered onto canvas tables or settling boxes, without passing over the machines.

There are many different devices that can be, and are, employed for sizing, but one of the simplest and most effective we show on the opposite page, giving all dimensions necessary to enable any carpenter or millwright to construct it.

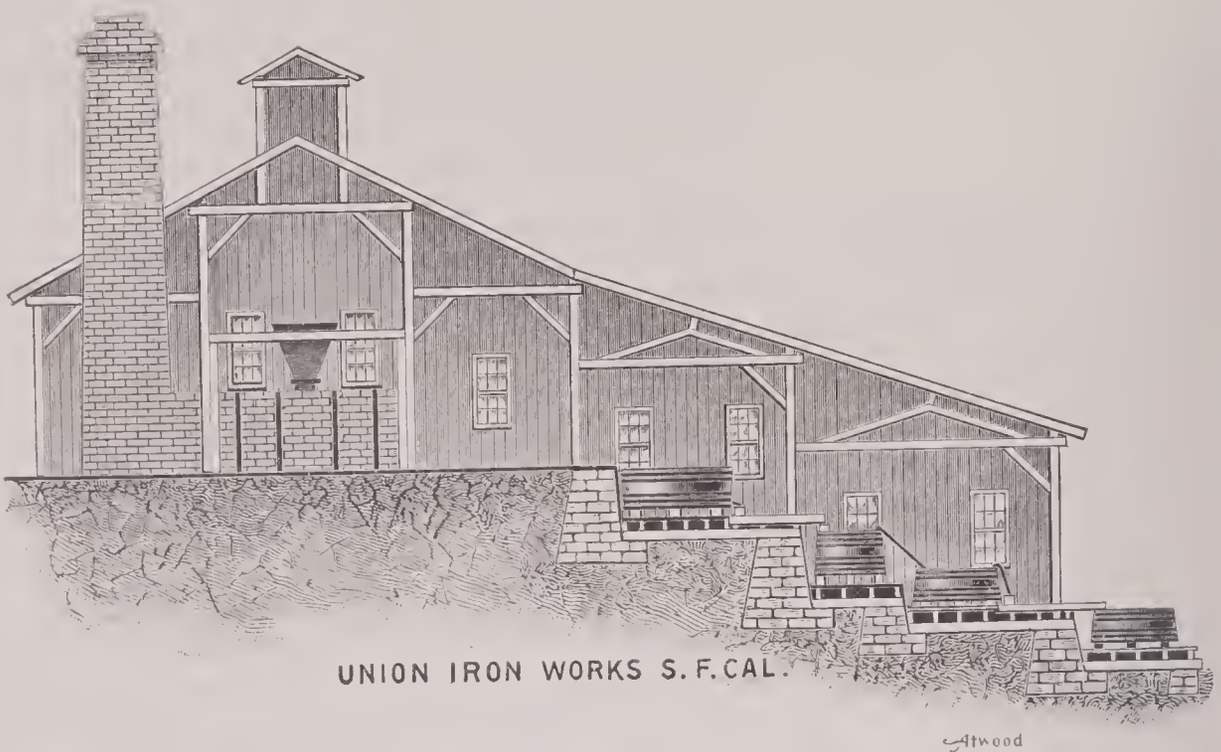
The sizer illustrated is of the simplest form, making only one separation of the pulp, or two sizes; the pulp from five stamps being conducted into it by the sluice at top, as shown; the heavier particles passing through the slot at bottom and out of the gate, while the finer particles are carried out through the overflow, thus effecting a separation, or sizing the pulp into two classes, the coarse and the fine, each of which should be treated on a separate concentrator, specially adjusted with reference to stroke, speed and inclination of the belt, to give the best results.

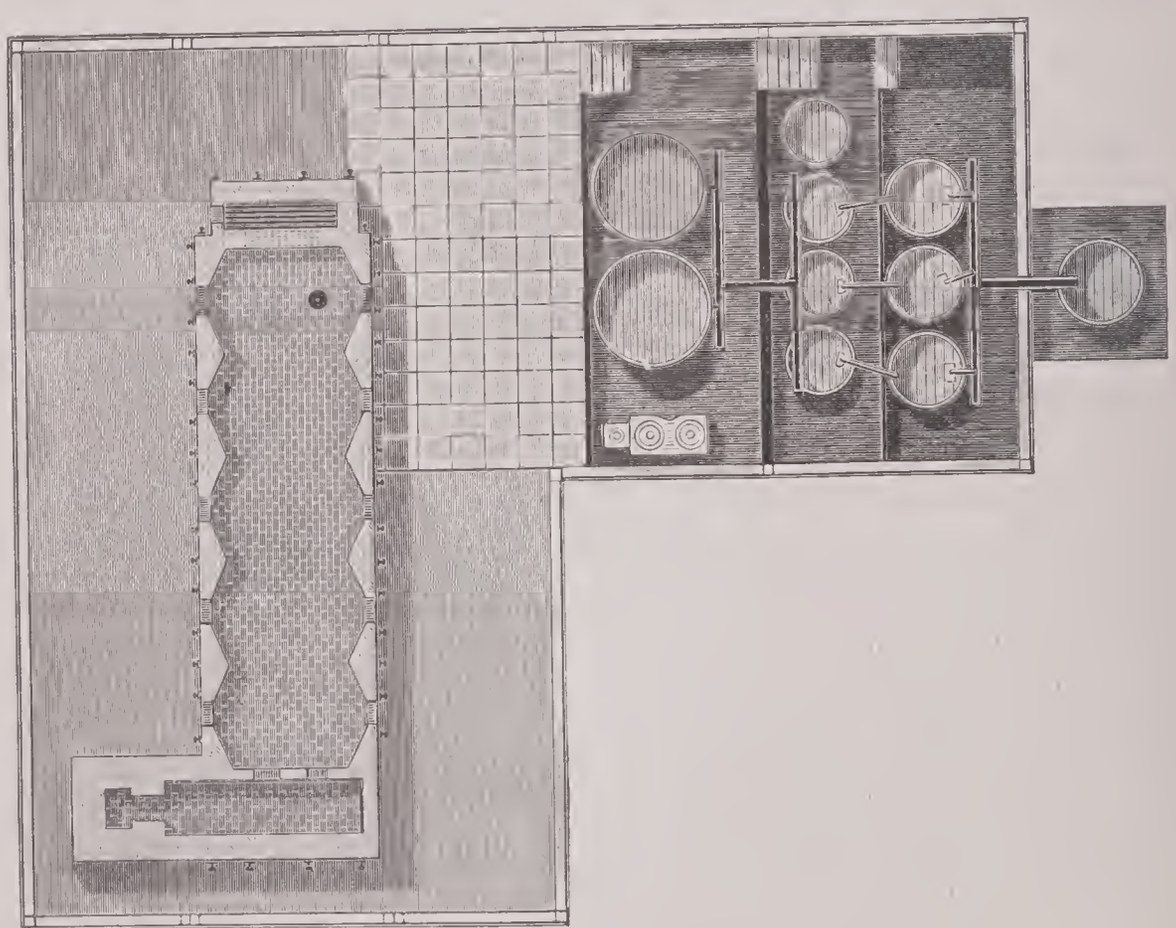
By passing the overflow into a second sizer one more grade or size is obtained, thus making as many sizes or grades as may be desired.

Any one can construct the sizer shown, and, after experimenting a little with different gate openings, any degree of separation required can be effected.

We furnish these sizers, when required, K. D. and boxed.

Weight, 50 pounds. Price, $5.00.





Chlorination Works.

Treatment of Concentrates.

The gold ores of California usually carry from one to two per cent of sulphurets, which are separated from the ore after passing through the batteries. These concentrates range in value from $40 to $200 per ton, chiefly in gold, though in many instances they contain from $12 to $20 in silver and from one to five per cent of copper.

The method usually employed for their treatment is that of chlorination (Plattner process) (see illustration on opposite page). This consists in roasting the concentrates in an ordinary reverberatory furnace to expel the sulphur, arsenic and other volatile, deleterious substances. Salt is added as the roast nears completion, and when a "dead roast" has been obtained (which is of the utmost importance) the ore is drawn from the furnace and spread upon the cooling floor; when cold, about six per cent of moisture is added; it is then screened into the leaching tanks, care being taken to have it lie as loosely as possible to facilitate the penetration of the chlorine gas, the screen used being usually ⅜" to ½" mesh. The tanks are filled to within about three inches of the top and chlorine gas (generated in lead holders) is introduced into the bottom of the tank, and remains on until ammonia held above the ore gives off fumes of ammonia chloride. This usually takes about four hours. When this point is reached covers are put on the tanks and luted with dough or any other suitable substance and the gas shut off. The tank is then allowed to stand for two days, during which time the gold contained in the ore has been converted into a terchloride of gold. The covers are then removed, water introduced and the terchloride of gold washed or leached out.

This "liquor" or lixivium is run into precipitating tanks, where by the use of a solution of sulphate of iron the gold is precipitated, falling to the bottom of the tank, forming a dark paste. The liquor is then siphoned off, the gold collected, washed with water until all the acid and iron salts are removed; it is then dried, melted and cast into bars, the average fineness being from 998 to 999½.

When the concentrates carry silver the roasting with salt has converted it into a chloride; this is leached out after the gold has been extracted, by using a solution of hyposulphite of soda. The lixivium from this leach is run into separate tanks, where the silver is precipitated by the addition of a solution of polysulphide of sodium or calcium. The precipitate is in the form of a sulphide of silver which is collected upon filters, washed, dried, and then reduced to a metallic state.

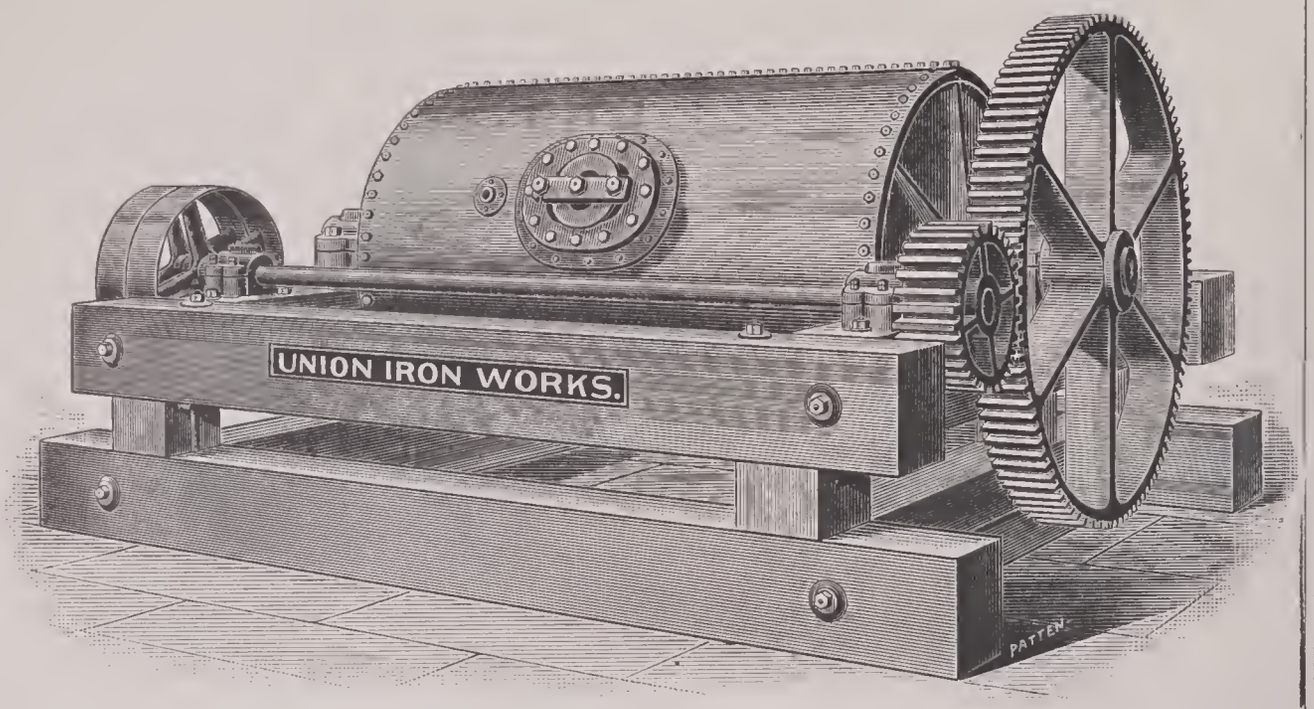
When the concentrates contain copper sulphides they are converted by roasting into sulphates and are leached out with the gold, and remain in the "liquor" after the gold has been precipitated; if the amount of copper carried in this liquor is sufficient to justify its being saved, the liquor, when siphoned from the gold precipitating tank, is run into another tank containing scrap iron, which precipitates the copper into a metallic form known as "cement copper."

By the process described above from 92 to 96 per cent of the assay value of the concentrates is obtained, the cost varying from $10 to $15 per ton of concentrates treated, depending upon local conditions as to labor and fuel.

The Plattner process, while slow in operation, meets with general favor—no moving machinery is required, there is nothing to break down and but little to wear out. A set of vats once installed will last indefinitely if properly taken care of, and painted with coal tar and asphaltum from time to time. The furnace is simple in construction and easy of operation.

We have a variety of patterns for generators and furnaces of different sizes and capacities; also build machinery for the Barrel process.

Plans, specifications and estimates furnished on application.



The Barrel Chlorination Process.

The Barrel Process, as distinguished from Plattner's Process, consists in generating the chlorine and dissolving the gold at the same time, within a revolving barrel.

The roasted sulphurets, together with the requisite quantities of water, sulphuric acid and chloride of lime, are placed within the barrel, which is then sealed and revolved slowly for about two hours. The entire contents is then discharged into a leaching vat, and the solution drawn off through a filter bed and precipitated as in the Plattner Process.

The illustration above shows our Chlorination Barrel, with a wrought-iron shell. The heads are made of cast iron, with trunnions to receive bearings and driving gear. The inside of the shell is lined throughout with sheet lead, making a casing absolutely tight, so no acid comes in contact with the iron. Each barrel of the larger type has a man and hand hole combined, the smaller one only a hand hole.

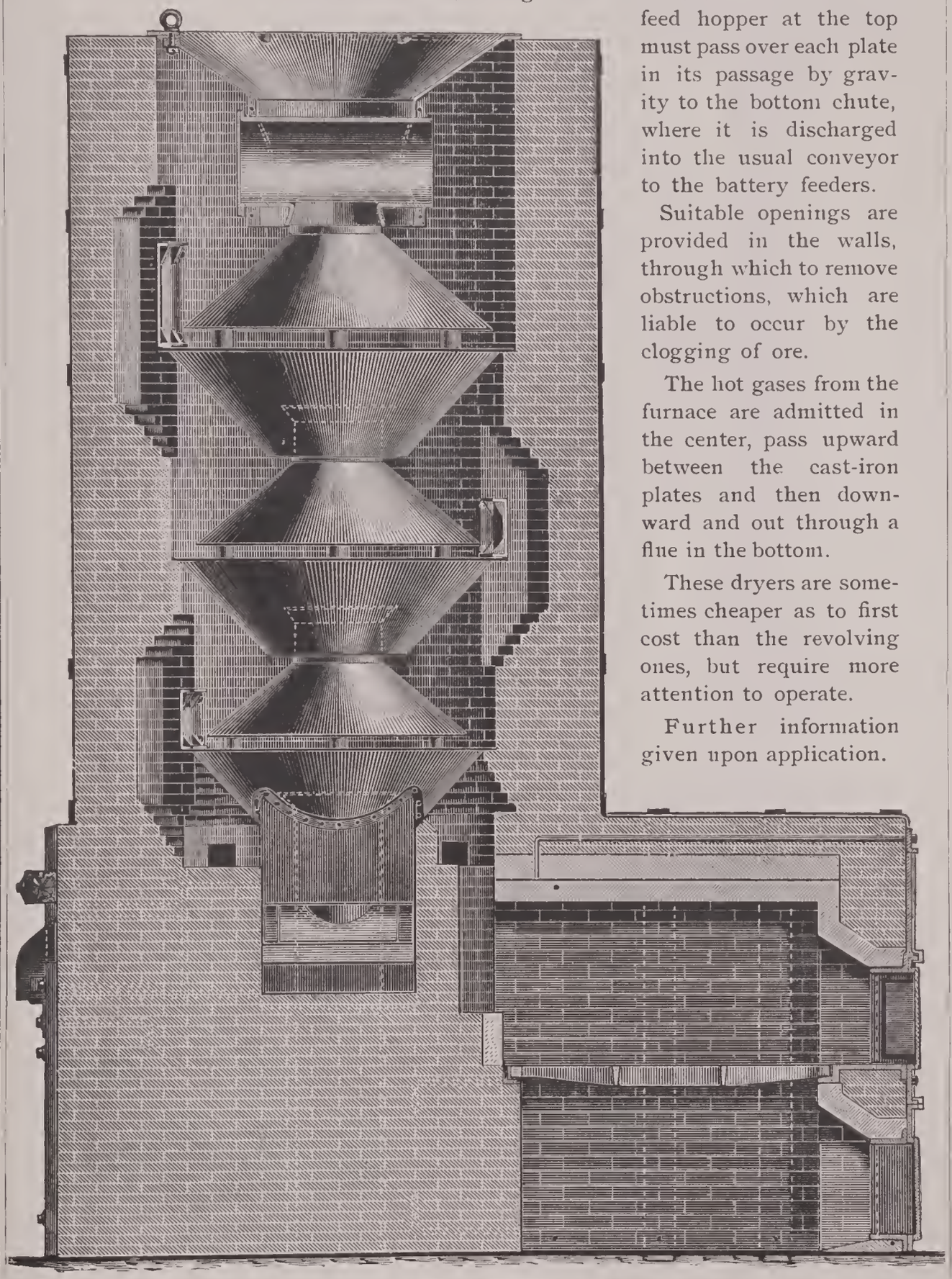
The speed of the barrel depends upon the size, varying from two to six revolutions per minute.

Sometimes wooden staves are used instead of a wrought-iron shell.

We build them of any required size.

The Shelf Dry Kiln.

The accompanying illustration shows our Shelf Dry Kiln used as an ore dryer. It is built of masonry in the shape of a vertical shaft, inside of which are a series of cast-iron umbrellas, one above the other, arranged so that the ore admitted from the feed hopper at the top must pass over each plate in its passage by gravity to the bottom chute, where it is discharged into the usual conveyor to the battery feeders.

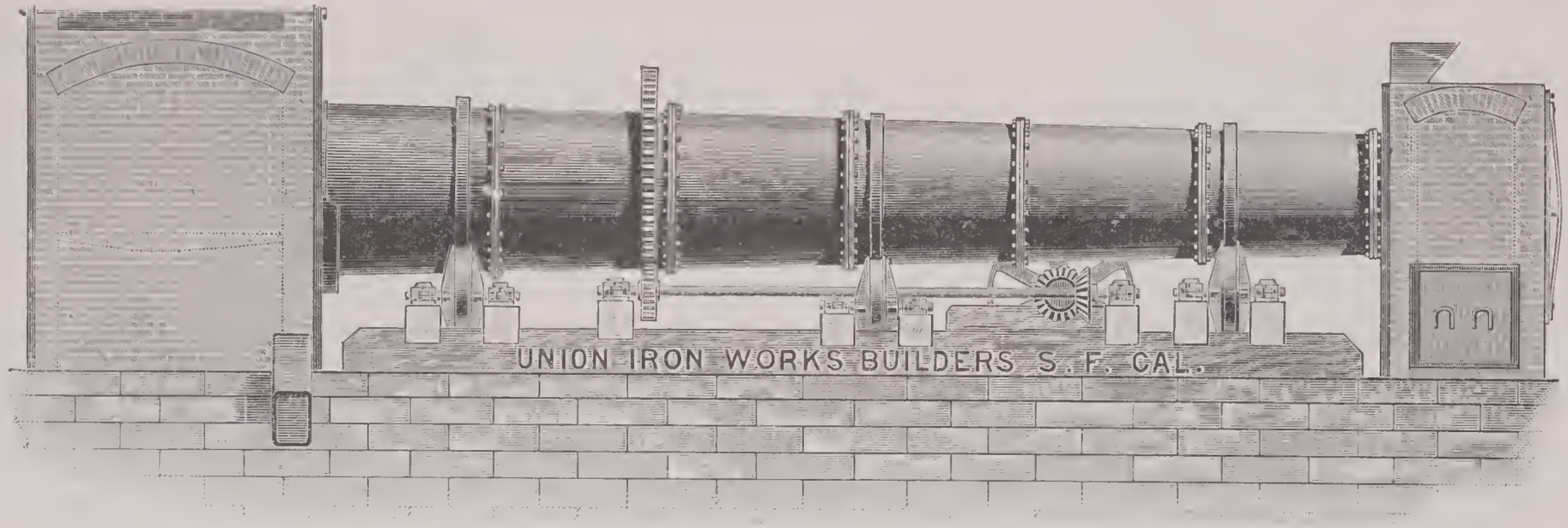


Suitable openings are provided in the walls, through which to remove obstructions, which are liable to occur by the clogging of ore.

The hot gases from the furnace are admitted in the center, pass upward between the cast-iron plates and then downward and out through a flue in the bottom.

These dryers are sometimes cheaper as to first cost than the revolving ones, but require more attention to operate.

Further information given upon application.



Revolving Ore Dryer.

The illustration above shows a style of dryer almost entirely used in dry-crushing mills where a large amount of ore is handled. The dryer consists of a cast-iron cylinder, made in sections for convenience in handling, and of a larger diameter at the fire end than that into which the ore is fed. The axis of the cylinder being horizontal, the ore gradually travels toward the fire end of the cylinder as it slowly revolves, and is finally discharged into bins ready for being crushed dry in the batteries. Shelves running lengthwise are attached to the inside of the cylinder, and, as it revolves, the shelves raise the ore and drop it through the flame, assisting to quickly and thoroughly dry it.

The dryer occupies but a small amount of space, and is economical in consumption of fuel, and requires but little power for its operation. The cylinder is driven by means of gears, as shown, and is supported on four rollers placed beneath.

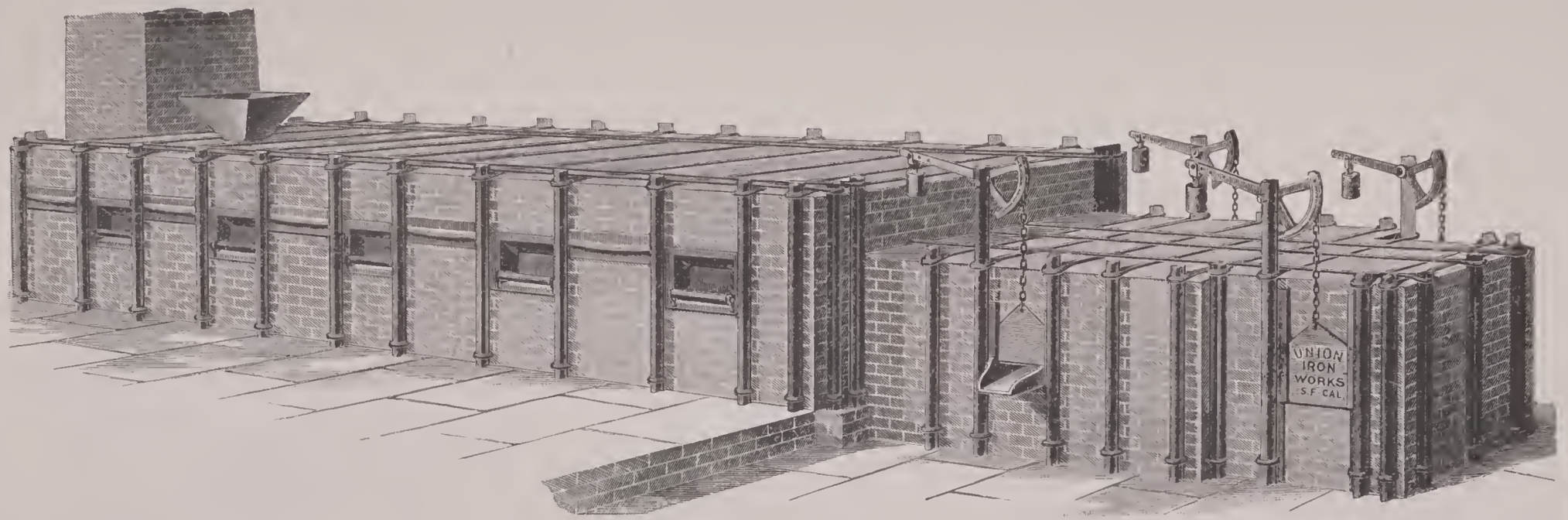
We furnish all iron work complete.

They are built in sizes of any capacity required.

Send for estimates.

TABLE OF SIZES, WEIGHTS, ETC.

No.	Diameter.		Length of cylinder, feet.	Capacity in tons per 24 hours.	Weight, pounds.	Price.
	Large end, inches.	Small end, inches.				
1	40	30	16	20 to 30	16,000	.....
2	50	34	24	40 to 50	21,000	.....



Roasting and Matting Furnace.

The illustration above shows a Roasting and Matting Furnace, which consists of a long hearth or floor of brick between two low walls and arched over with fire brick to confine the heat and conduct the flame from the fire at the lower end over the ore and into the chimney.

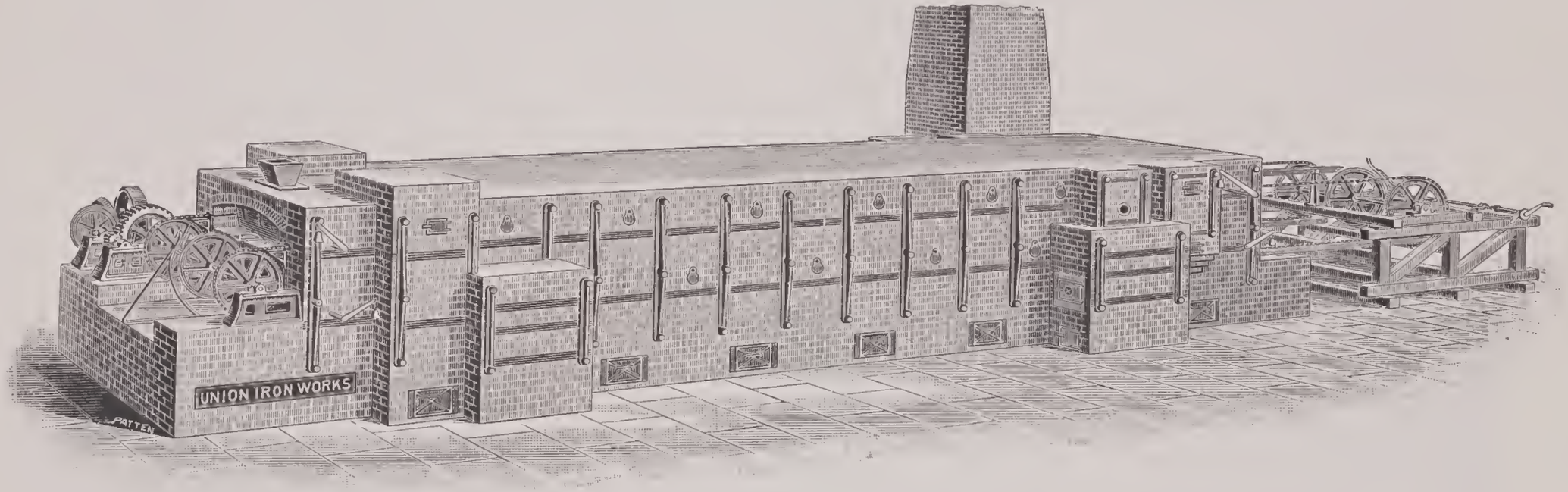
The ore is fed into the upper end through a hopper and is worked forward by paddles, rakes and hoes (the operation being called rabbling), until it reaches the discharge door. The working doors with rollers to carry the hoe in the side walls are so designed that the operator can swing his hoe over a large surface, and no two doors placed opposite, so that the hoe reaches easily the ore that otherwise would accumulate near the opposite walls.

The hearth is usually divided into several floors, rising slightly one above the other from the discharging or finishing hearth, the highest being at the charging end, this bringing the ore up closer to the diminishing heat.

We supply the working doors and frames, discharge and fire doors and frames, with counterbalance weights, chains, pulleys and brackets, grate bars and bearers, tie rods and also T rail, when old rail is not to be obtained at the site of contemplated works. They are built in sizes of any capacity required.

Plans for erection are furnished when furnace is ordered.

Prices given upon application.



The DuBois Improved O'Hara Roasting Furnace.

The DuBois Improved O'Hara Roasting Furnace.

The illustration on the opposite page shows the DuBois Improved O'Hara Roasting Furnace. It is built with two separate hearths, or sections, for desulphurizing and chloridizing the ore, both processes being performed at one operation.

Triangular iron frames, having scrapers or plows attached, are fastened to an endless chain running lengthwise through the furnace. The scrapers or plows are set at an angle, one turns the ore towards the center and the other towards the wall. They go through the furnace about once a minute and turn up new surfaces to the flames.

The steel chains run in cast-iron troughs built in the walls on each side of the hearths to protect them from the intense heat and chemicals in the ore.

The roof and hearth of each compartment are close together so as to confine the heat with the ore.

In operating the furnace, the ore is fed continually from the battery into the hopper, through which it falls into the upper hearth. The scrapers drawn by the endless chain stir the ore over and over again, and move it gradually along until it falls on the lower hearth; from where it passes through and falls into a pit built beneath the furnace.

The ore passing along through the compartments is both desulphurized and chloridized; for the latter, salt should be mixed with the ore as it is fed into the hopper, and becomes thoroughly distributed with it by the stirring action of the plows.

Additional oxygen is introduced through a blower, which increases the intensity of the heat and has proven a valuable feature in this furnace. The ore, in passing gradually through the compartments, becomes more and more heated, and about the time the final heat is required it is directly in front of the fire.

The time ore requires for roasting and chloridizing depends entirely upon its character. Ordinarily, from five to ten hours is sufficient. Only one attendant is necessary to take care of the fires and watch the machinery.

The construction of the furnace is such that the heat from the upper and lower hearth passes down side flues into a lower or supplementary chamber to catch any waste dust which may escape from the hearths above. This method of construction is to supplant the old custom of long and expensive dust flues independent of the furnace.

Further information given upon application.

Howell-White Furnace.

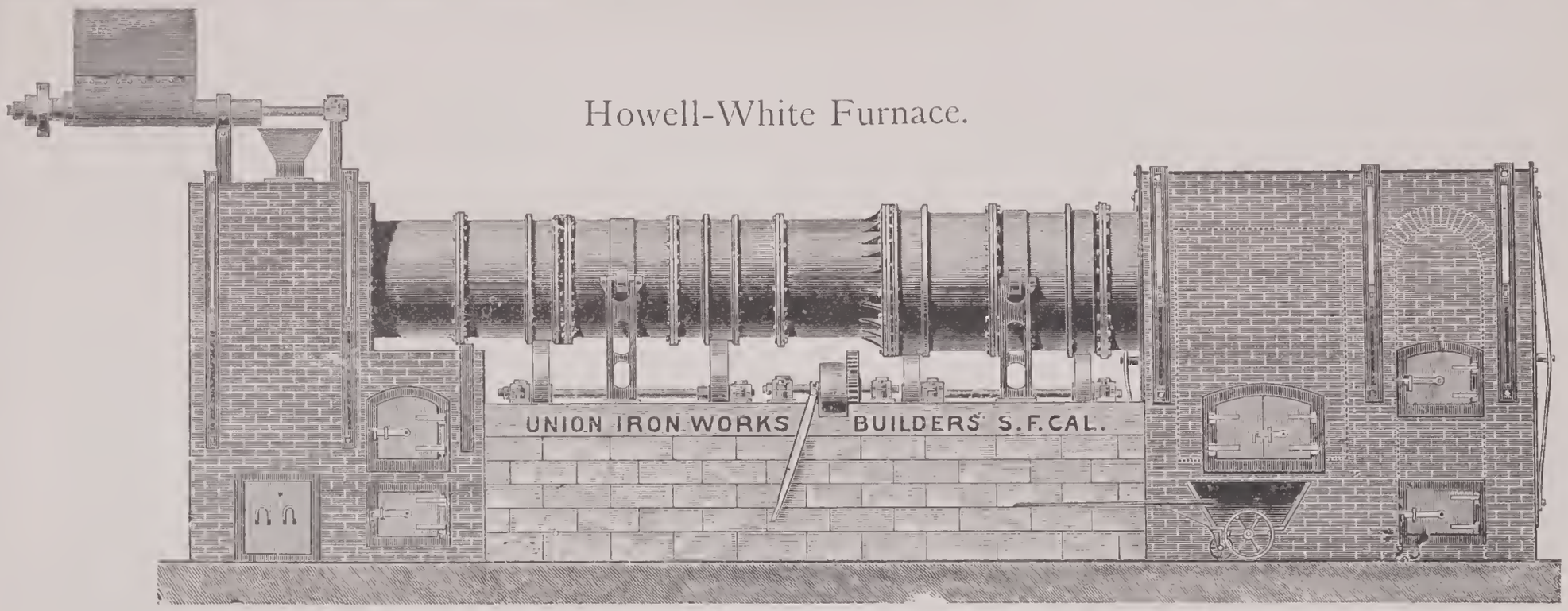


TABLE OF SIZES, WEIGHTS, ETC.

Sizes of cylinder	32″x 21′	42″x 27′	50″x 28′	60″x 30′
Capacity in tons, in 24 hours	10 to 16	16 to 22	20 to 32	30 to 54
Fuel, cordwood	½ to 1¼	1¼ to 2	2½ to 3½	3½ to 5
Revolutions of cylinder, per minute	8 to 14	7 to 11	5½ to 9	4½ to 7½
Horse-power to rotate cylinder, while roasting	1	1¾	2½	3
Speed of inside periphery, per minute, in feet	60 to 85	65 to 100	70 to 105	73 to 110
Approximate distance ore falls, in feet	200 to 600	210 to 610	225 to 650	235 to 700
Approximate number of pounds of ore in cylinder	200 to 300	360 to 500	675 to 900	875 to 1,275
Number and weight of fire brick for lining cylinder, 7 pounds each	9,000 6,200	1,500 10,500	1,900 13,300	2,300 16,100
Number and weight of fire brick for fire box, 7 pounds each	450 3,150	550 3,850	650 4,500	750 5,250
Approximate weight of iron, in pounds	16,000	25,000	35,000	43,000
Approximate number of common brick required	36,500	53,000	94,000	102,000
Price	.....	.....	.....	.....

Ore is in cylinder from ten to twenty minutes, according to character. From two to ten per cent of salt is required for a chloridizing roasting.

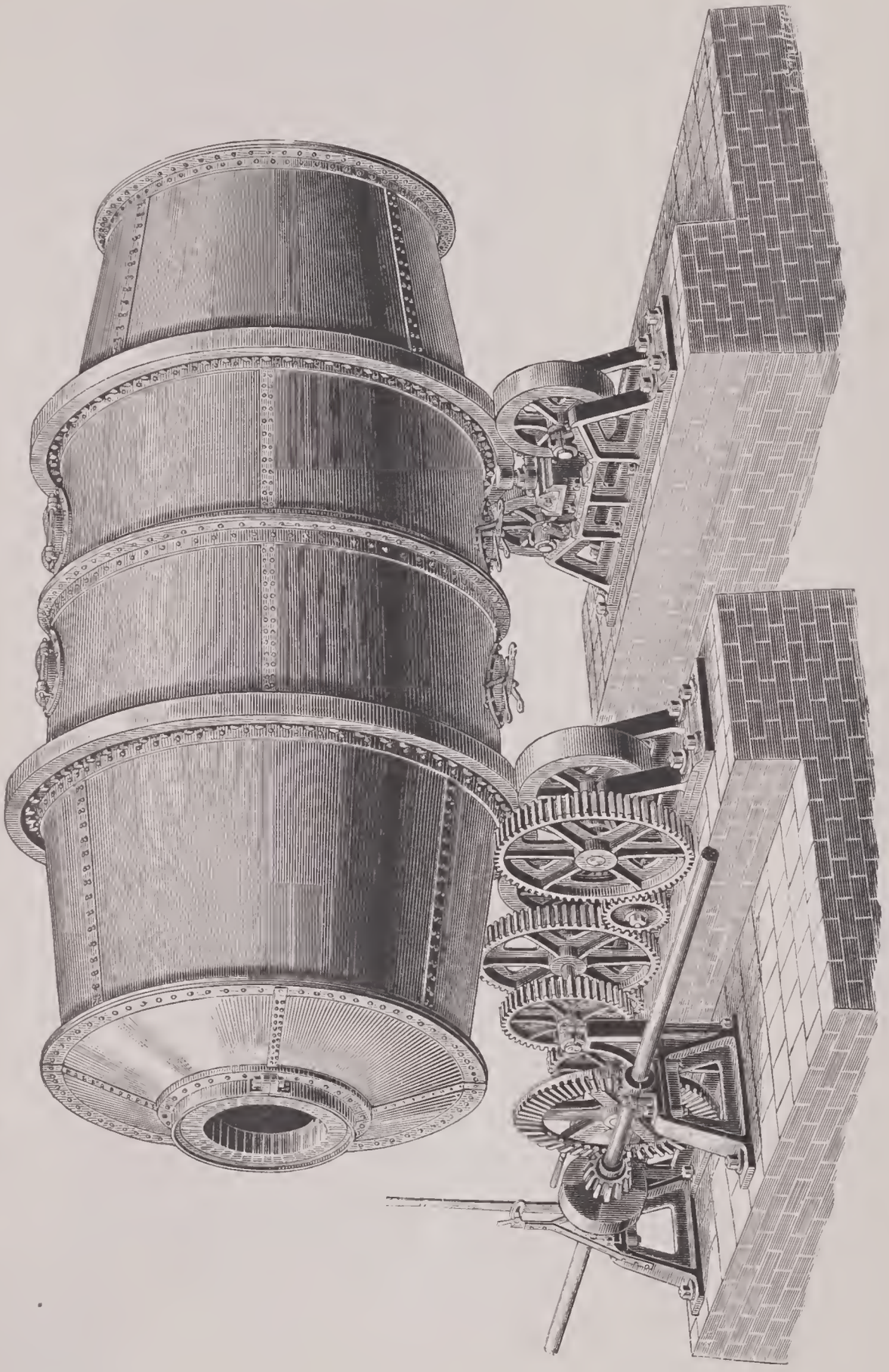
Howell-White Furnace.

The illustration on the opposite page shows the well-known Howell-White Furnace. The cylinder is made in sections to facilitate its transportation. The portion of the cylinder nearest the fire end has a larger external diameter than the rest of the cylinder, but the internal diameter is the same throughout, when operated. This is due to the fire end being lined with fire-brick to protect it from the extreme heat at this end; the balance of the cylinder, however, is exposed, as the heat at the upper end is not so great. Projecting bricks are arranged spirally in the lining of the fire end, for the purpose of showering the ore through the flames. For the same purpose at the other end are arranged projecting cast-iron shelves.

The cylinder is supported on four rollers, and is revolved by the friction between it and the wheels—the latter being driven by means of gears or pulleys. Guide rollers acting against its sides keep it in its central position on top of the wheels. As shown in illustration, the inclination of cylinder can only be changed by the use of adjustable rollers, which we furnish for this purpose when desired. By changing the inclination of the cylinder, ore can be retained a longer or shorter period, as may be necessary. The furnace is continuous and automatic in its operation. It is fed at the upper end with dry pulp from the stamp, or other pulverizers, by means of a suitable screw feeder, placed between the feed hopper and cylinder, discharging its product regularly into a hot ore bin at the lower end, from whence it is drawn as required. The ore is submitted to a gradually increasing temperature during its passage through the furnace, which is the correct theory of roasting.

An auxiliary fire is sometimes used with these furnaces for roasting the dust which escapes from the main furnace.

We furnish all iron work complete for these furnaces.



Improved Brückner Furnace.

Improved Brückner Furnace.

The illustration on the opposite page shows the ordinary type of the Improved Brückner Furnace. The cylinder revolves through friction on four rollers driven by a set of gearing and pulleys. The tires are riveted to the body of cylinder shell, and the rollers are made of best chilled iron to give them long and uniform wear. The body of the shell is made of steel plate, the middle of cylindrical form, and the two ends conical. On the center section are two sets of doors directly opposite for receiving and discharging the material. The brickwork for fireplace and flue is not shown on illustration. This is usually modified to suit the wishes of our customers.

Ore is roasted in this furnace in batches of several tons, and when thoroughly roasted and chloridized is discharged, and then receives another batch. The furnace is lined throughout with fire-brick, and protects the shell from the intense heat and gases.

Being of smaller diameter at the ends than in the center, the ore is thrown to and fro, changing its position continually and exposing new surfaces and particles to the fire. A charge can be roasted as long or as short a time as required in this furnace, thus adapting it particularly to base ores.

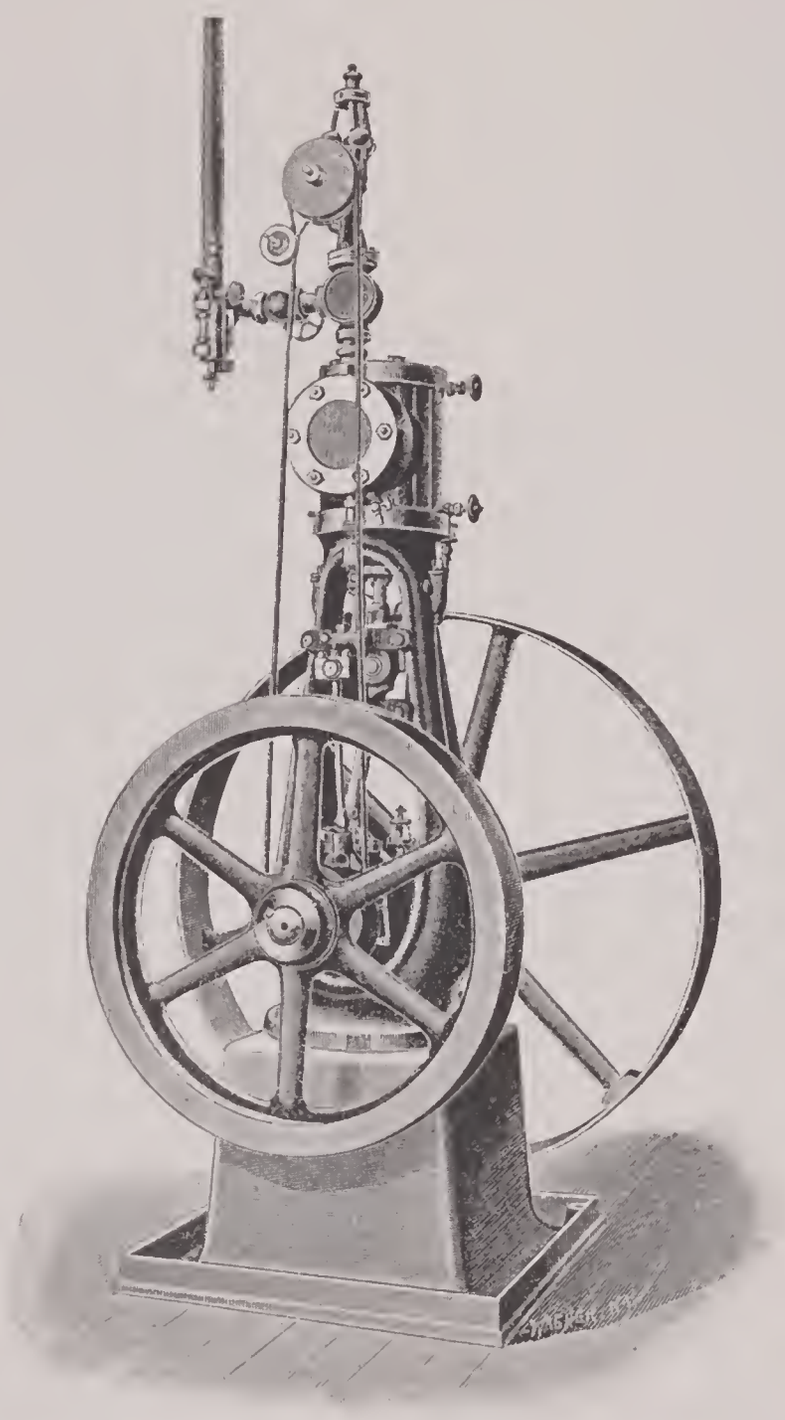
The capacity depends largely upon the ores, some requiring but four or five hours to be thoroughly roasted and chloridized, while others require much longer.

The furnaces give excellent satisfaction; all parts are made strong and durable, and material and workmanship are of best quality.

Plans, specifications and estimates furnished upon application.

TABLE OF SIZES.

Number.	Diameter in feet.	Length in feet.	Capacity per charge in tons.	Number of fire bricks.	Number of common bricks, including 10′–0 of dust flue.	Weight in pounds.	Price.
1	6	12	3 to 4	1,600	18,000	18 000	.....
2	7	16	5 to 8	2,400	20,000	30,000	.....
3	8	18	9 to 11	3,500	24,000	40,000	.....



Vertical Center-crank Engine.

(HIGH SPEED.)

Vertical Center-crank Engine.

(HIGH SPEED.)

The illustration on the opposite page shows a self-contained high-speed vertical center-crank engine, with plain slide valve.

The frame is mounted on a broad base, with an upturned edge to catch any drippings of oil or water.

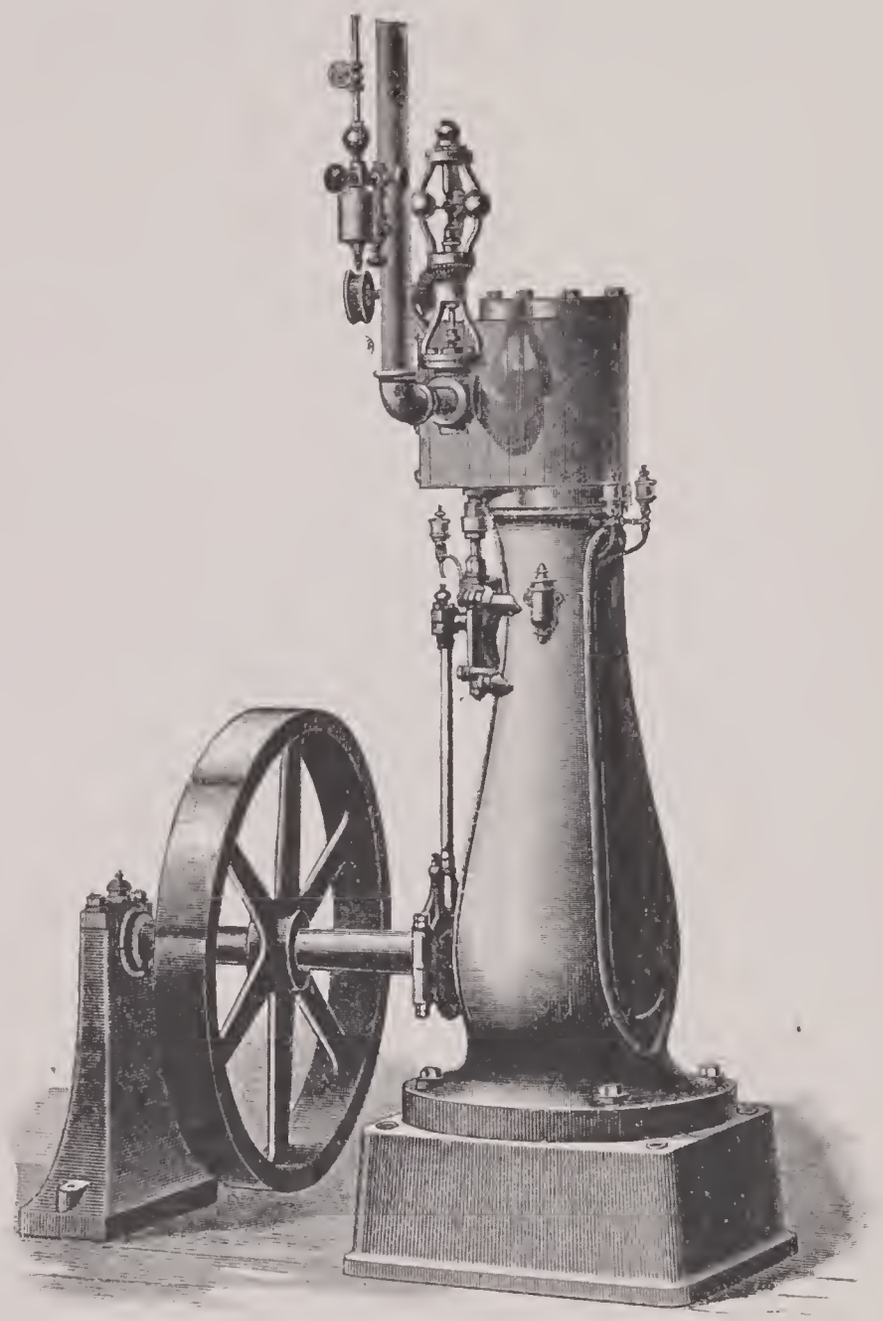
The crank shaft is made of forged steel. The engine is provided with oil cups, sight-feed lubricator, drain cocks, globe valve and governor, and is all fitted up and tested before leaving the works.

Steam pipe connections between engine and boiler, exhaust pipe and foundation bolts are subject to order, and charged extra.

PRICE LIST, STANDARD SIZES, ETC.

Horse-power initial press're 60 lbs.	Cylinder Sizes in Inches.		Revolutions per miuute.	Diameter of crank shaft.	Bandwheel.		Size of steam pipe.	Size of exhaust pipe.	Shipping weight.	Price.
	Diameter.	Stroke.			Diameter.	Face.				
2	3	5	250	1¾	24	4	¾	1	600	$180.00
4	4	6	250	1 15/16	30	4	1	1	935	275.00
6	5	6	250	1 15/16	30	5	1	1¼	1,000	310.00
8	5½	7	250	2 7/16	32	5½	1¼	1½	1,350	390.00
11	6½	7	250	2¾	40	6	1¼	1½	1,500	430.00
14	7	9	225	2 15/16	42	6	1½	2	2,530	500.00
19	8	9	225	2 15/16	42	8	1½	2	2,640	600.00

Further information given upon application.



Vertical Side-crank Engine.

Vertical Side-crank Engine.

On the page opposite is illustrated a vertical side-crank slide-valve engine, with outboard bearing.

The frame is in one piece, firmly secured to a cast-iron pedestal.

The balance wheel is faced for a belt, and the shaft is key-seated the entire distance between bearings, to provide for securing additional pulleys.

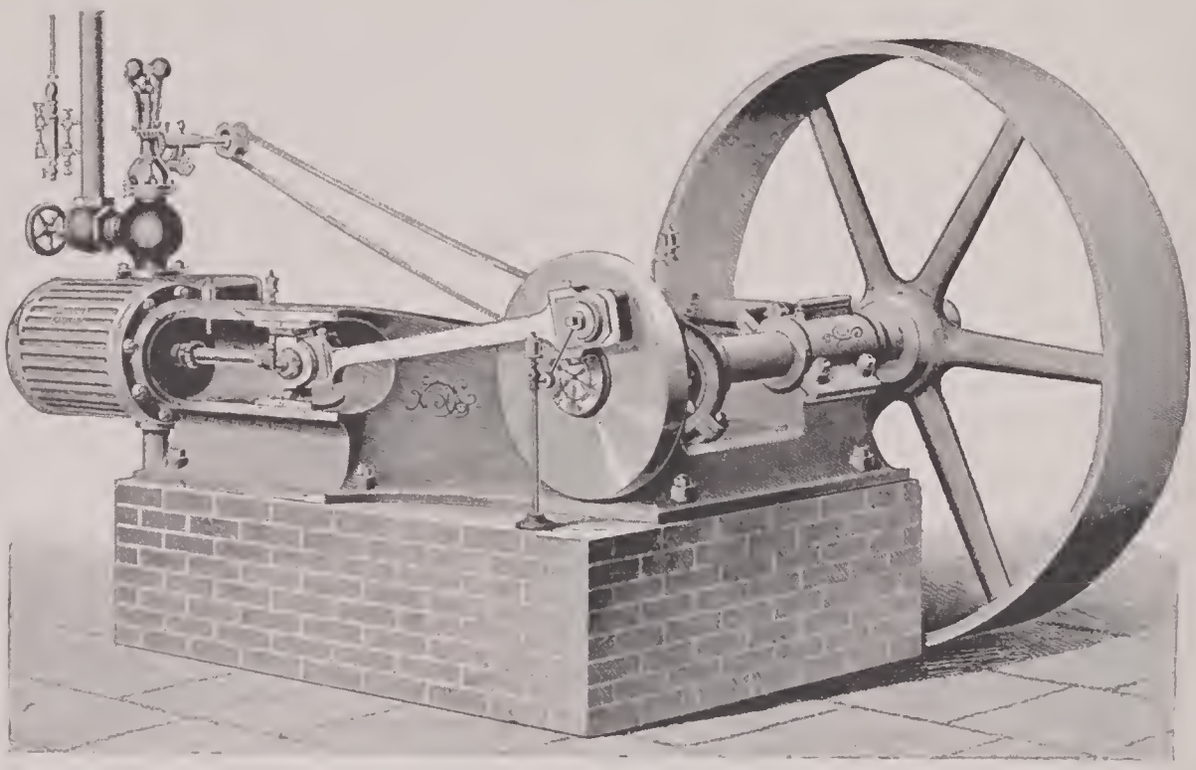
The engine is in running order as it leaves the works, being provided with governor, sight-feed lubricator, oil cups and cylinder cocks.

Pipe connections between boiler and engine, exhaust pipe and foundation bolts are provided, when desired, at a small additional cost.

PRICE LIST, STANDARD SIZES, ETC.

Horse-power initial press're 60 lbs.	Cylinder sizes in inches.		Revolutions per minute.	Diameter of crank-shaft.	Bandwheel.			Size of steam pipe.	Size of exhaust pipe.	Weight.	Price.
	Diameter.	Stroke.			Diameter.	Face.	Weight.				
17	9	12	125	$3\frac{15}{16}$	48	9	900	2	2½	3,500	$840.00
21	10	12	125	$4\frac{3}{8}$	48	12	1,200	2½	3	4,180	950.00

Further information given upon application.



Horizontal Slide-valve Engine.

(SELF-CONTAINED.)

The illustration above shows a horizontal slide-valve engine, self-contained. In it are embodied all valuable features known in this class of machinery. All parts are easily accessible in case of repairs or otherwise.

The crank shaft is made of best hammered steel. It is supported upon bearings cast integral with the engine frame, which is of girder type. The cylinder overhangs and is free to expand, the weight being taken by the engine frame.

The valves and parts are constructed for free passage of steam to suit speed without a loss of pressure.

The governor, throttle valve, steam, oil and water fittings are all of the best quality.

For table of sizes see opposite page.

Horizontal Slide-valve Engine.

(SELF-CONTAINED.)

PRICE LIST, STANDARD SIZES, ETC.

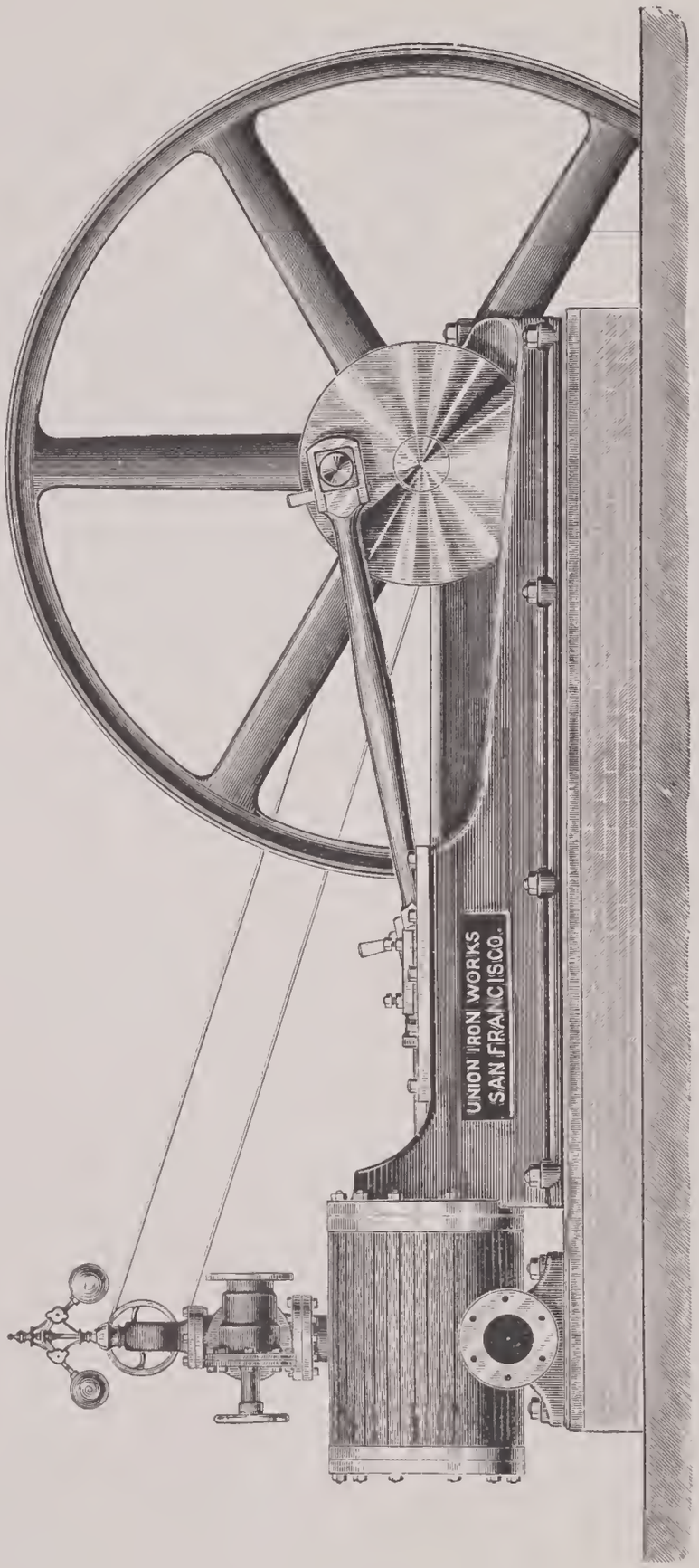
Horse-power.	Cylinder, inches.		Revolutions per minute.	Diameter of crank-shaft.	Bandwheel.		Size of steam pipe.	Size of exhaust pipe.	Total weight.	Price.
	Diameter.	Stroke.			Diameter.	Face.				
15	7	10	240	3⅜	40	8½	2	2½	1,600	$230.00
20	8	10	240	3⅜	44	10½	2	3	1,750	265.00
25	9	12	200	4⅜	48	12½	2½	3	2,950	360.00
30	10	12	200	4⅜	54	12½	2½	3½	3,200	390.00
35	10	14	200	4⅞	60	14½	3	3½	3,800	450.00
40	11	14	200	4⅞	66	14½	3	4	4,000	485.00
50	12	16	180	5⅜	72	17	3½	4	5,400	575.00
60	13	16	180	5⅜	78	17	3½	4½	5,700	600.00
80	14	18	160	6⅛	84	19	4	5	7,800	810.00

The fixtures included, besides Band-wheel and Governor, are Stop-valve, Spanner Wrench, Sight Feed Cylinder Lubricator, Ball Oiler and Stand for Wrist, Wipe Cup for Cross-head, Drip-cup for Eccentric, Oil Cups, Drain Cocks and Governor Belt.

Foundation Bolts and Plates *will be furnished if wanted* as an extra.

A narrow-rimmed Fly-wheel of same weight as Band Fly-wheel may be substituted at same price, but an extra pulley to go with the narrow-rimmed Fly-wheel *is charged for as an extra.*

Further information given upon application.



The Union Horizontal Slide-valve Engine.

The Union Horizontal Slide-valve Engine.

The illustration on the opposite page shows a horizontal plain slide-valve engine of the most improved type, with an outboard bearing. It is particularly designed for mines, mills, smelters, etc., where machinery is subject to heavy and continuous duty and rough usage.

A feature worthy of note is the frame, which is of extraordinary weight and stiffness. The engraving shows the general design and construction so clearly that little description is necessary.

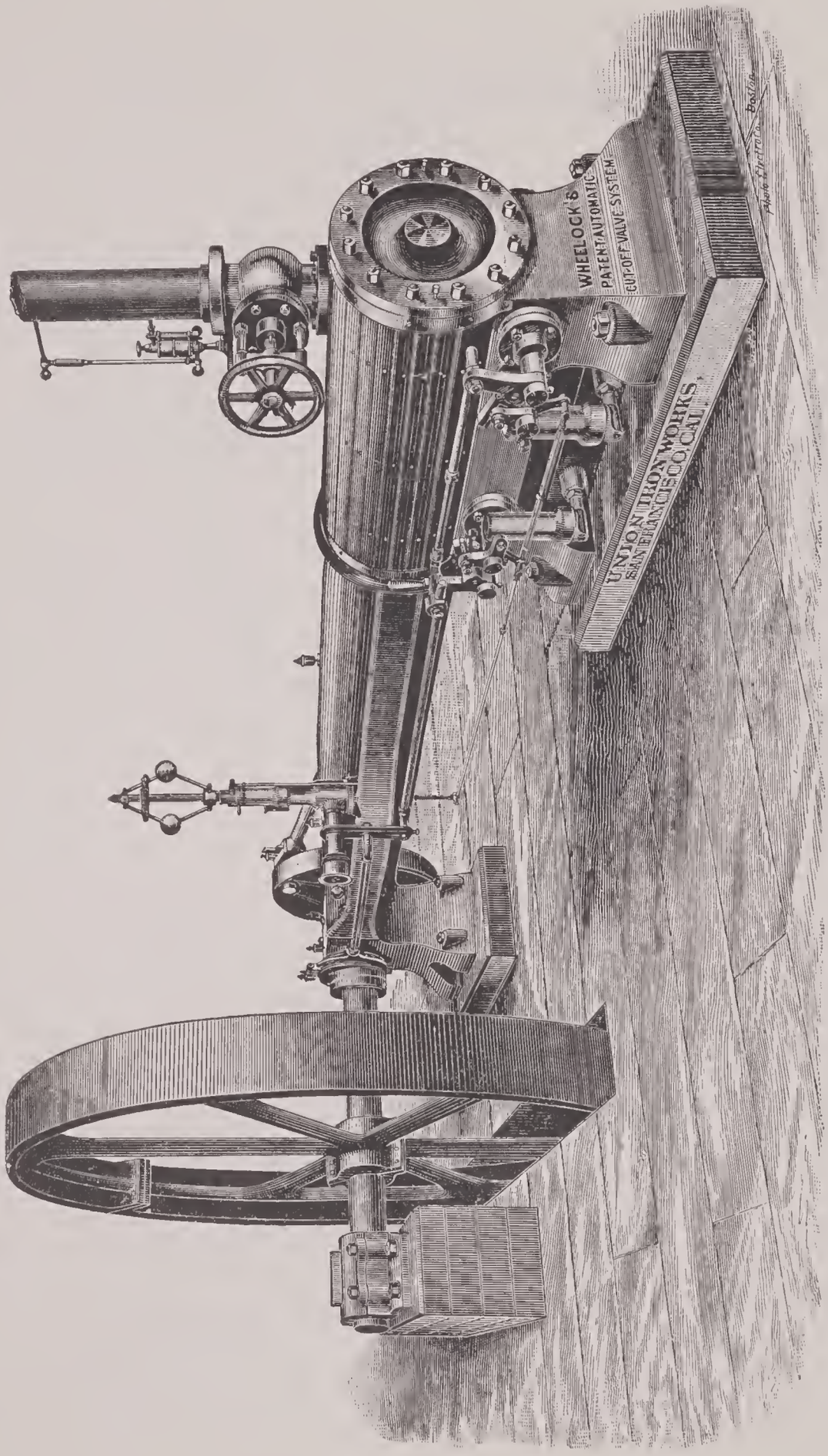
The crank shaft is made of best hammered steel. The engine throughout is built of best material, and all parts are easily accessible and adjustable in every way.

Steam pipe connections between engine and boiler, exhaust pipe and foundation bolts are subject to order, and charged extra.

Further information given upon application.

PRICE LIST, STANDARD SIZES, ETC.

Horse-power.	Diameter of cylinder, inches.	Stroke of piston, inches.	Revolutions per minute.	Bandwheel.			Total weight engine, pounds.	Price.
				Diameter, feet.	Face, inches.	Weight, pounds.		
12	6	8	200	4	8	600	1,200	.....
14	6	12	175	4	8	850	1,800	.....
26	8	12	175	5	11	1,100	3,300	.....
40	10	12	175	6	13	1,500	5,600	.....
45	10	16	140	6	15	2,800	6,600	.....
50	10	20	125	7	17	3,300	7,500	.....
65	12	20	125	7	21	4,000	8,400	.....
70	12	24	106	8	23	4,800	11,000	.....
100	14	30	90	10	25	5,400	17,000	.....



The Wheelock Corliss Engine.

The Wheelock Corliss Engine.

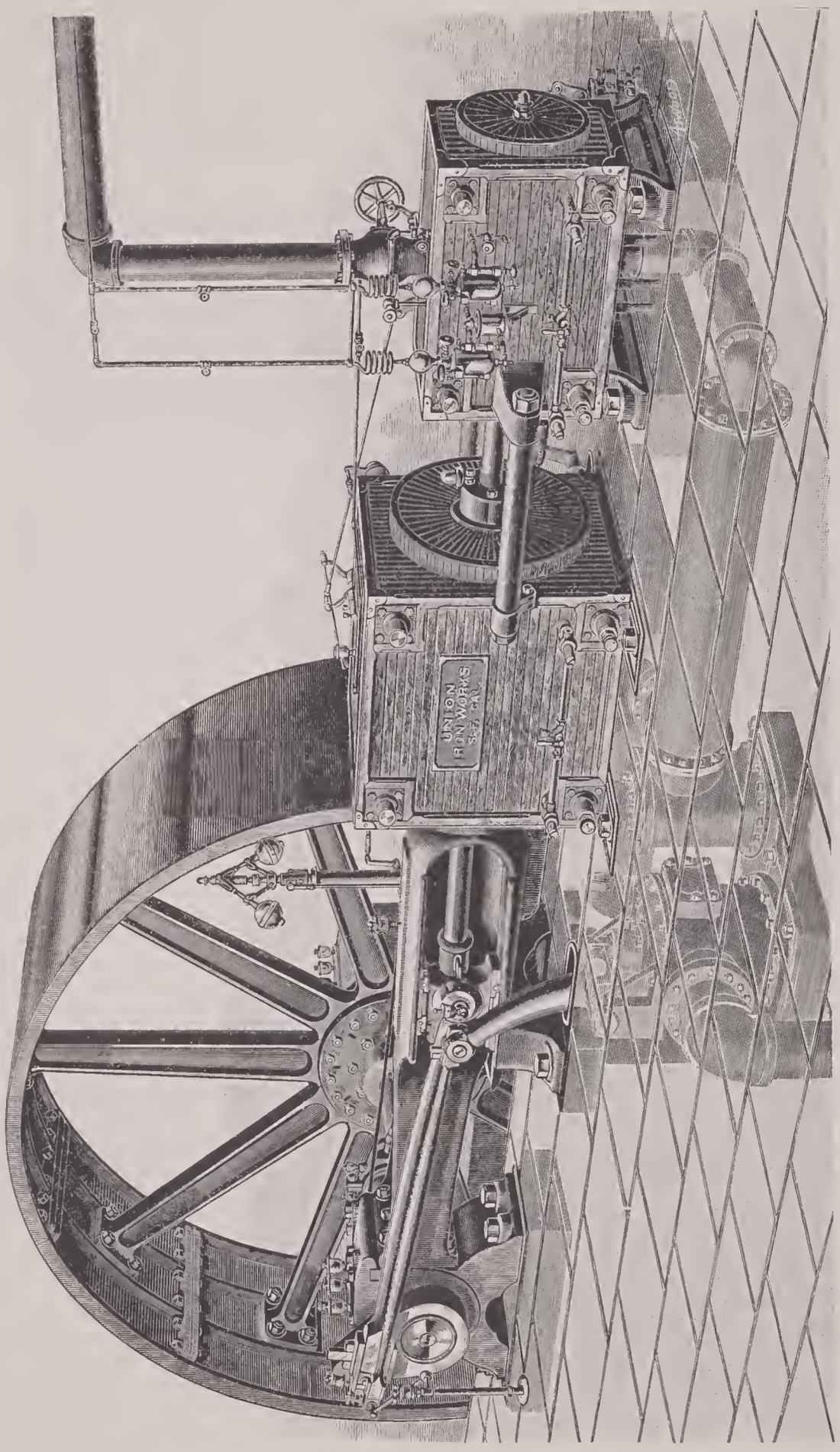
The Wheelock Corliss Engine is one of the simplest types of engine using detaching valve gear, and, although one of the oldest, it is still one of the most popular and reliable automatic engines in use. The peculiar construction of the valves, and the fact that they are suspended on hardened and ground stems, carried in hardened steel bushings, insures freedom from any considerable friction or cutting of the valve faces, and the arrangement of the valves is such that considerable latitude is possible in the adjustment of the points of release and compression, combined with a wide range of cut-off.

The governor is powerful and sensitive, and close regulation can be depended on under all conditions of load. The piston is provided with the well-known Wheelock packing, and the valve stems are self-packing, no stuffing boxes being necessary. It is an economical, efficient and durable engine, and the workmanship, material and finish is first class in every particular.

PRICE LIST, SIZES, ETC.

Indicated horse-power ¼ cut-off, 100 lbs. pressure.	Diameter, cylinder, inches.	Stroke of piston, inches.	Revolutions per minute.	Bandwheel.			Approximate total weight, pounds.	Price.
				Diameter, feet.	Face, inches.	Weight, pounds		
88	12	30	92	9	15	5,800	14,000	$2,000.00
120	14	30	92	10	19	8,000	17,000	2,400 00
180	16	36	84	12	21	10,000	23,000	3,100.00
186	16	42	80	12	23	12,000	26,000	3,600.00
224	18	36	90	12	25	13,000	29,500	3,750.00
232	18	42	80	14	23	14 000	32,000	4,000.00
249	18	48	75	15	25	15,000	35,500	4,400 00
285	20	42	80	15	27	16,000	37,000	4,600.00
306	20	48	75	16	27	18,000	41,500	5,000.00

Further information furnished upon application.



Tandem Compound Corliss Engine.

Tandem Compound Corliss Engines.

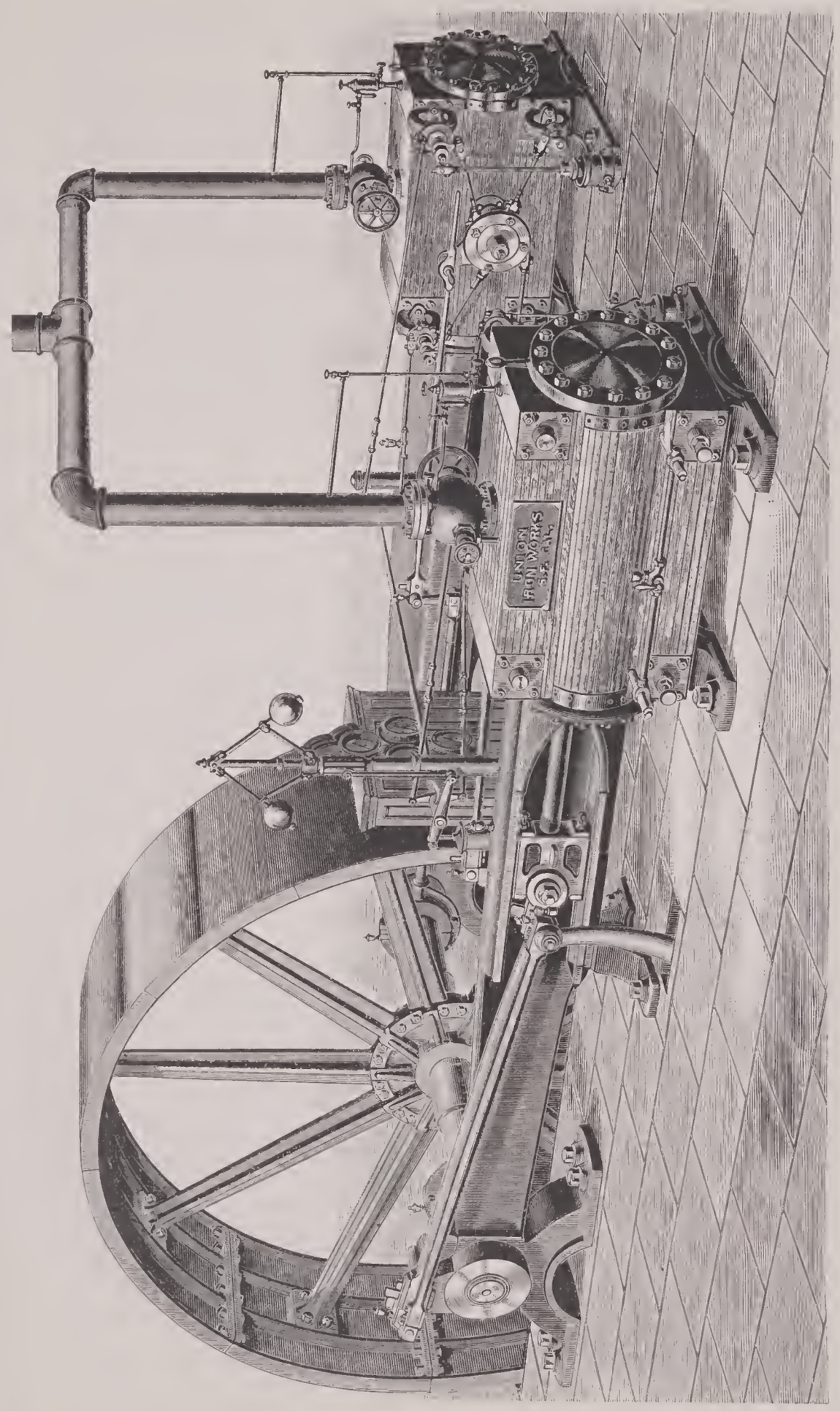
The illustration on the opposite page shows a Tandem Compound Corliss Engine with receiver and condenser. The general construction and design of our compound engines embody the principal features of our Single Improved Corliss Engines. The size of cylinders and proportions relative to the compound principle are designed to meet the requirements of our customers, and to obtain the best practical results.

The tandem engine has some advantages over the cross compound; its first cost is less, it requires less floor space, has fewer working parts, consequently less wear and tear. These engines can be used to run either condensing or non-condensing. The most economical, however, are the compound condensing.

PRICE LIST, SIZES, ETC.

Horse-power, 100 lbs. pressure	High-pressure cylinder, inches.	Low-pressure cylinder, inches.	Stroke, piston, inches.	Revolutions per minute.	Bandwheel.			Estimated total weight, pounds.	Price.
					Diam., feet.	Face, inches.	Weight, pounds.		
135	12	18	36	90	12	20	9,000	.....	.....
167	14	20	36	80	14	24	13,500	.....	.....
252	16	24	42	80	16	24	15,000	.....	.....
318	18	26	48	75	16	30	18,000	.....	.....
420	20	30	48	75	18	38	24.000	.....	.....
480	22	32	48	75	20	42	27,000	....	.....
504	22	32	54	70	20	44	30,000	.....	.....
636	24	36	54	70	22	47	34,000	.....	.....
656	24	36	60	65	22	47	34,000	.....	.....
712	26	38	54	70	24	50	36,000	.....	.....
734	26	38	60	65	24	50	36,000	.....	.....
895	28	42	60	65	24	52	38,000	.....	.....
988	30	44	60	65	26	52	41,000	.....	.....
1,089	32	48	66	55	26	54	44,000	.....	.....
1,286	34	50	66	55	28	56	52,000	.....	.....
1,176	34	50	72	50	28	56	52,000	.....	.....
1,375	36	54	72	50	30	60	61,000	.....	.....

Prices and specifications furnished upon application.



Cross Compound Corliss Engine.

Cross Compound Corliss Engine.

The Cross Compound Corliss Engine has certain characteristics which for large powers make this type preferable to the tandem compound, previously described. The cross compound type is more accessible, the individual running parts are smaller, and turning effort on the crank shaft is more even, permitting the use of a lighter flywheel than could be used on a tandem engine.

There can be one or two bandwheels, as may be required for work to be done. In case of very large engines, it is advisable to have a pillow block between frame bearings and two wheels.

The frames are of girder type, strong and insuring rigidity. The workmanship, design and material used in the construction of our cross compound engines is the same as in our tandem compound engines.

A receiver is placed between the high and low pressure cylinders. This receiver acts as an equalizer to maintain a uniform pressure upon low-pressure piston.

It is thus seen that the advantages of the Compound Condensing Corliss Engine are as follows:

First—The engine having its steam and exhaust valves independent of each other and cutting off at any point in the stroke.

Second—The condenser removes a large resistance from in front of advancing piston.

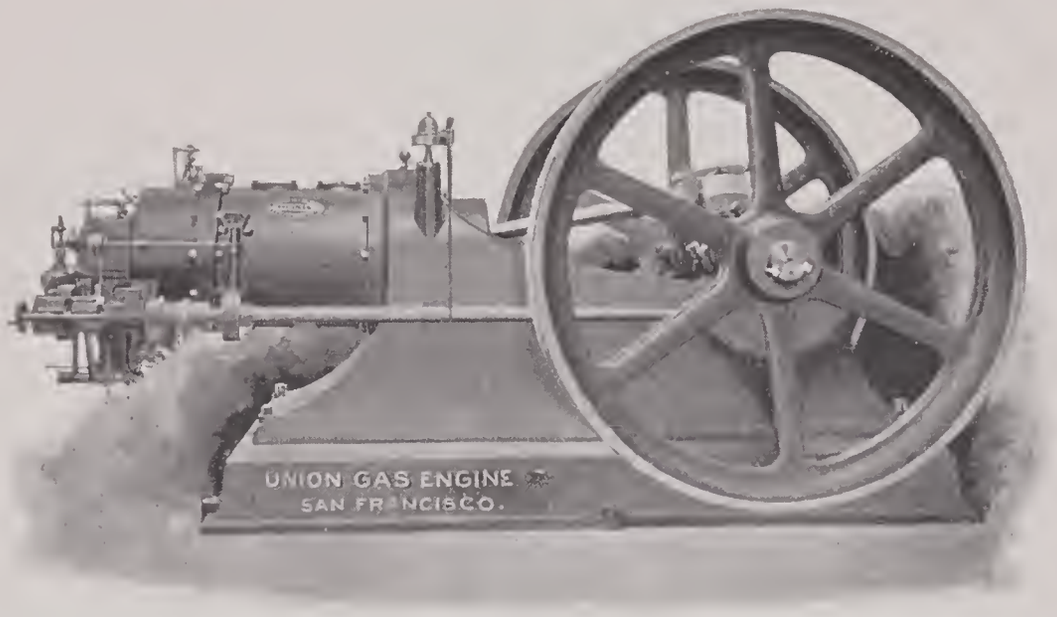
Third—A high grade of expansion is permissible, at the same time extreme variations of temperature in the cylinders are avoided.

This type of engine represents the best results yet known in producing power from heat.

Special designs furnished upon application.

PRICE LIST, SIZES, ETC.

Horse-power, 100 lbs. pressure, ratio 1 to 2¼.	High-pressure cylinder, inches.	Low-pressure cylinder, inches.	Stroke, piston, inches.	Revolutions per minute	Bandwheel.			Estimated total weight, pounds.	Price.
					Diam., feet.	Face, inches.	Weight, pounds.		
135	12	18	36	90	12	20	9,000	51,400	.....
167	14	20	36	80	14	24	13,500	54,000	.....
252	16	24	42	80	16	24	15,000	85,000	.....
318	18	26	48	75	16	30	18,000	97,000	.....
420	20	30	48	75	18	38	24,000	122,000	.....
480	22	32	48	75	20	42	27,000	144,000	.....
504	22	32	54	70	20	44	30,000	152,000	.....
636	24	36	54	70	22	47	34,000	.....	.....
656	24	36	60	65	22	47	34,000	.....	.....
712	26	38	54	70	24	50	36,000	.....	.....
734	26	38	60	65	24	50	36,000	.....	.....
895	28	42	60	65	24	52	38,000	.....	.....
988	30	44	60	65	26	52	41,000	.....	.....
1,089	32	48	66	55	26	54	44,000	.....	.....
1,286	34	50	66	55	28	56	52,000	.....	.....
1,176	34	50	72	50	28	56	52,000	.....	.....
1,375	36	54	72	50	30	60	61,000	.....	.....



Union Gasoline Engines.

The illustration above shows the latest type of the Union Gasoline Engine. It is particularly adapted for operating prospecting machinery, dynamos, pumps, etc., in mining localities, where the supply of water, coal and wood is limited. The fuel used is either natural or manufactured gas, gasoline, naphtha, benzine or distillate.

It is entirely automatic in action, and is fitted with a very sensitive governor which allows gas to be used only in proportion to the work to be performed.

The engine requires one-eighth of a gallon of gasoline for each horse-power, per hour, up to six horse-power, and for the larger sizes one-tenth of a gallon. The average cost of gasoline is from ten to fifteen cents per gallon.

Its speed is remarkably steady and the regulation very close.

No boiler required, no fire, gives good results, is very economical, and serves well the purpose for which it is intended.

See opposite page for price list and standard sizes.

Union Gasoline Engines.

(SELF-CONTAINED.)

PRICE LIST, STANDARD SIZES, ETC.

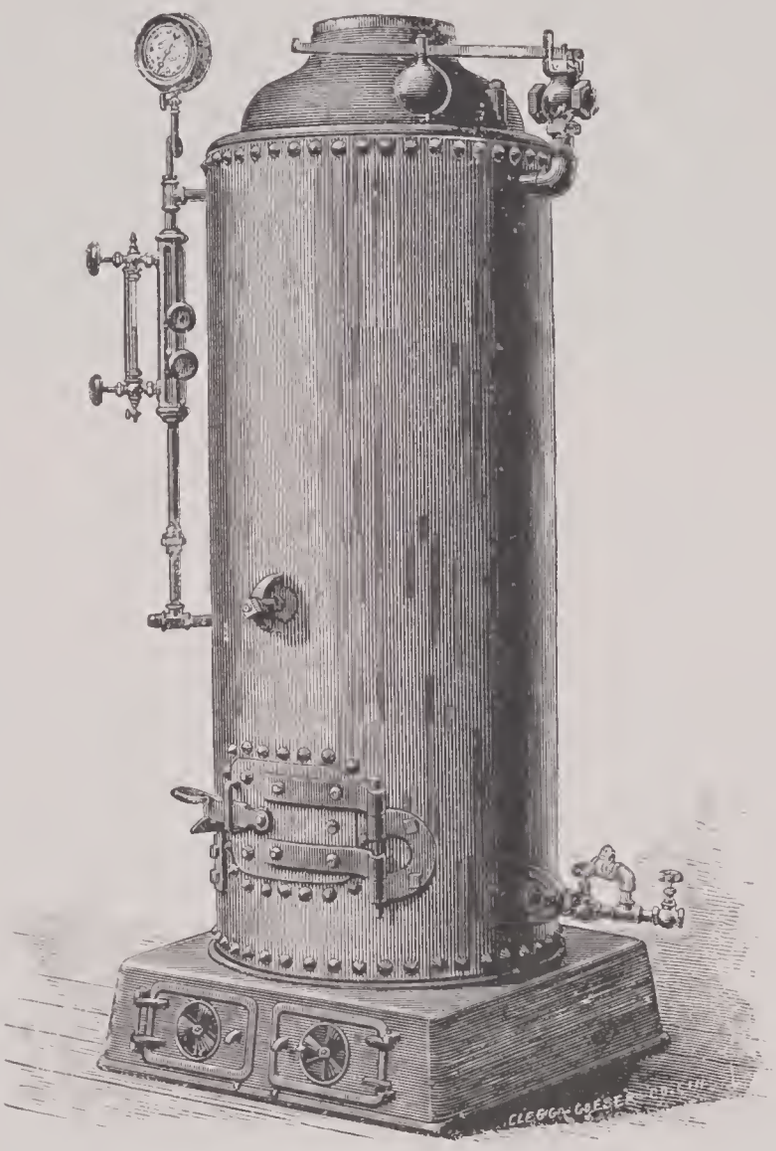
Actual horse-power.	Pulley. Diameter, inches.	Pulley. Face, inches.	Revolutions per minute.	Approximate weight, pounds.	Price.
3	6	6	400	630	$ 325.00
5	10	8	420	1400	500.00
10	24	12	250	4500	900.00
15	30	14	220	7000	1,225.00
18	32	14	220	7300	1,375.00
25	..	..	180	9500	1,875.00
30	..	..	180	11,000	2,125.00
35	..	..	200	13,000	2,525.00
50	..	..	160	17,000	2,875.00
60	..	..	175	19,000	3,125.00

All engines over twenty horse-power are fitted with self-starters. A similar attachment can be put on any size if ordered, but as the smaller engines start so easily it is not necessary.

Only the best materials are used in each and every part of the engines. The crank shafts and connecting rods are of the best open hearth forged steel.

Every engine is carefully tested before leaving the works, and is guaranteed to develop the power for which it is sold.

Further information cheerfully given upon application. Correspondence solicited.



Upright Tubular Boilers.

[FROM 4 TO 60 HORSE-POWER.]

Upright Tubular Boilers.

The illustration on the opposite page shows an Upright Tubular Boiler. We particularly recommend this type for small powers, or where economy in space is required. The bases are made of cast iron, with large ash-doors; hoods of most improved patterns; hand holes above crown-sheets and in bottom of legs.

These boilers are made of best quality steel, and are tested at 150 pounds water pressure before leaving works.

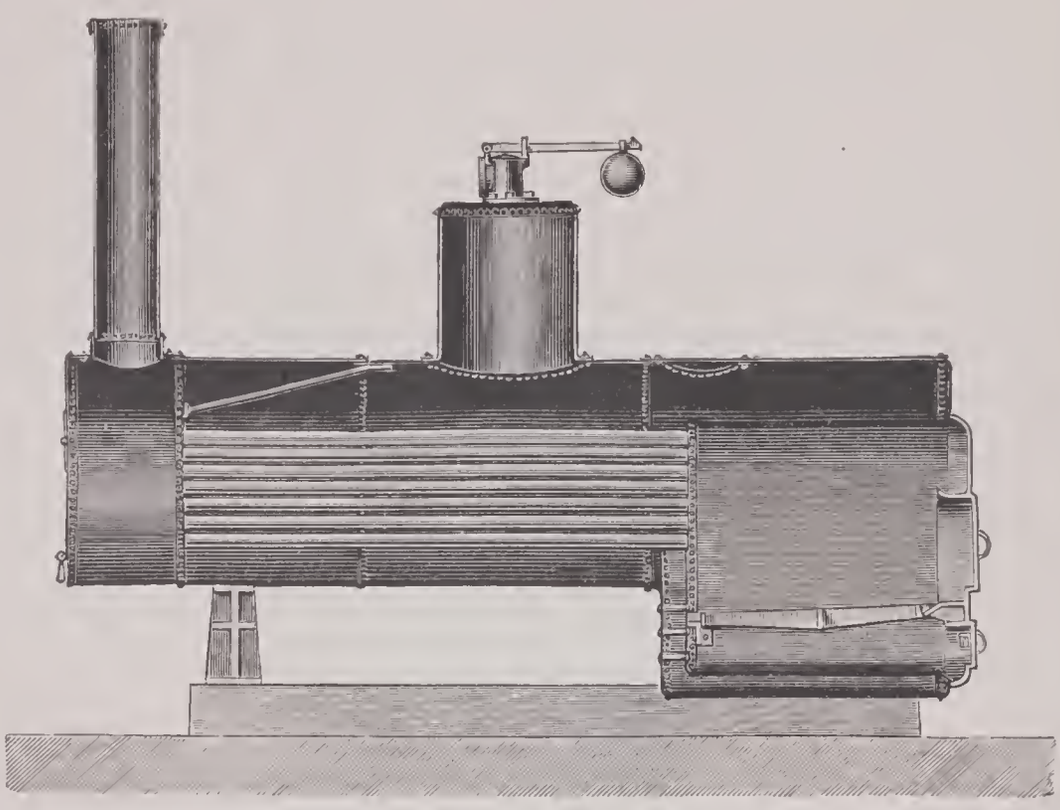
The table below is calculated at twelve square feet of heating surface to the horse-power.

PRICE LIST, WEIGHTS, ETC.

Horse-power.	Diam. of boiler.	Height of boiler.	Diam. of furnace.	Height of furnace.	Thickness of steel in shell and furnace	Thickness steel in heads.	Length of tubes.	Number of tubes all 2" diam.	Actual sq. ft. fire surface	Wt. of boiler without base and fixtures.	Wt. of boiler, base and fixtures.	Total wt. of boiler.	Price.
4	24	4	20	24	1/4	3/8	24	31	45	900	280	1,180	$ 95.00
5	24	5	20	24	1/4	3/8	36	31	60	1,000	280	1,280	105.00
6	24	6	20	24	1/4	3/8	48	31	75	1,100	280	1,380	110.00
7	30	5	25	27	1/4	3/8	33	53	90	1,300	460	1,760	130.00
9	30	6	25	27	1/4	3/8	45	53	118	1 500	460	1,960	142.00
12	30	7	25	27	1/4	3/8	57	53	148	1,700	460	2,160	160 00
12	36	6	31	27	9/32	3/8	45	68	151	1,950	780	2,730	170.00
15	36	7	31	27	9/32	3/8	57	68	186	2,200	780	2,980	205.00
18	36	8	31	27	9/32	3/8	69	68	221	2,450	780	3,230	220.00
23	42	8	37	33	9/32	3/8	63	88	280	3,000	1,000	4,000	270.00
27	42	9	37	33	9/32	3/8	75	88	325	3,300	1,000	4,300	290.00
31	42	10	37	33	9/32	3/8	87	88	383	3,600	1,000	4,700	310.00
36	48	9	43	33	5/16	3/8	75	124	435	4,300	1,325	5,625	385.00
41	48	10	43	33	5/16	3/8	87	124	500	4 700	1,325	6,025	405.00
47	48	11	43	33	5/16	3/8	99	124	565	5,100	1,325	6,425	430.00
50	54	10	48	33	5/16	3/8	87	150	608	5,700	1,725	7,425	500.00
60	60	11	55	36	5/16	3/8	96	171	720	7,000	2,050	9,050	600.00

"Fixtures" comprise the Steam Gauge, Water Gauge, Gauge Cocks, Safety Valve, Blow-off Valve, Check and Stop Valves.

Further information given upon application.



Standard Semi-portable Locomotive Boiler.

The above illustration shows a Semi-portable Locomotive Boiler, mounted on skids.

This type is suitable for work up to sixty horse-power, and in many cases cheaper than boilers built in masonry.

The workmanship and material is of the best quality.

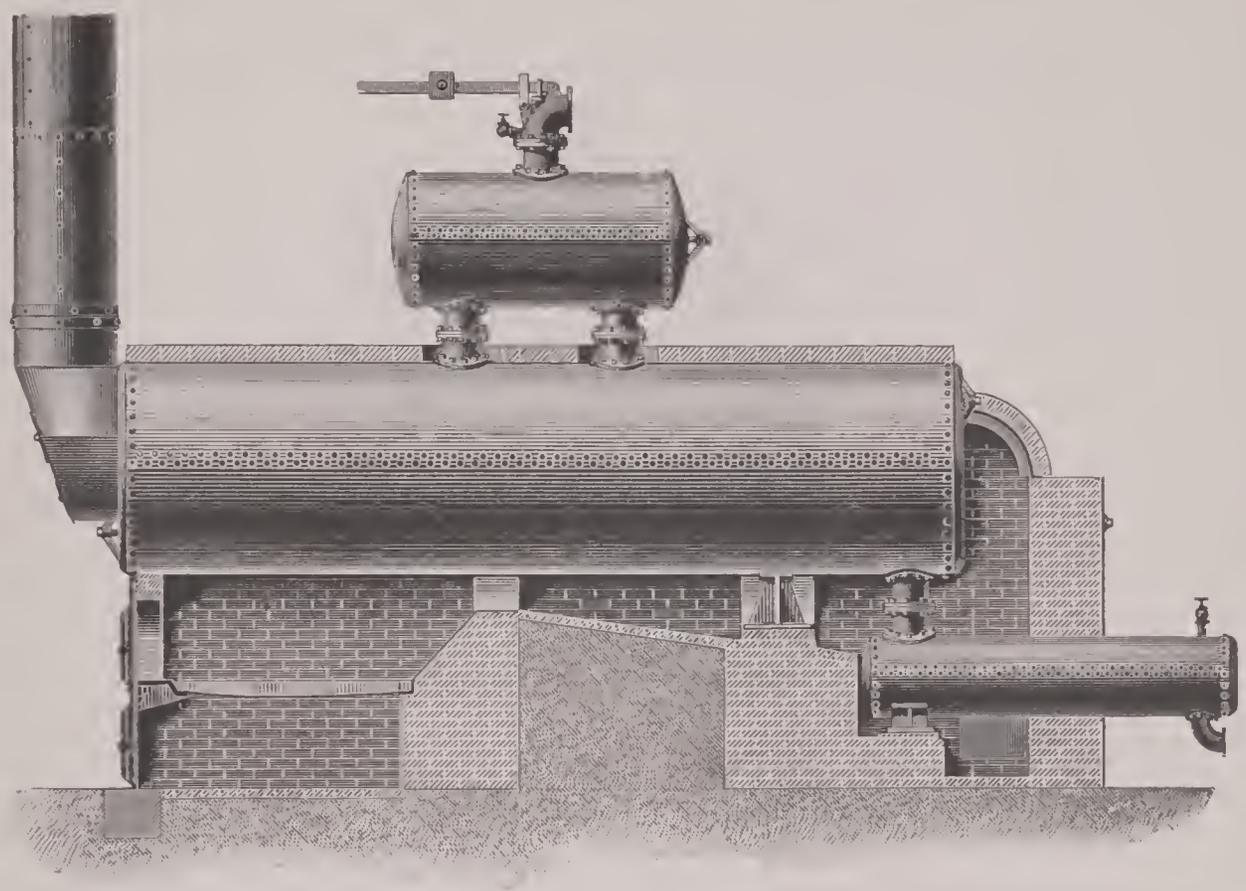
PRICE LIST, WEIGHTS, ETC.

Horse-power.	Diam. inches.	Fire-box.			Tubes.			Diam. of smoke-stack.	Height of smoke-stack, feet.	Weight.	Price.
		Length, inches.	Width, inches.	Height, inches.	No.	Diameter, inches.	Length, inches.				
6	26	34	21	29	17	3	54	12	18	2,900	$235.00
8	28	36	22	32	18	3	60	13	18	3,200	250.00
10	30	38	24	34	22	3	72	14	18	3,650	285.00
12	32	38	26	38	26	3	72	15	20	4,300	305.00
15	32	44	26	38	26	3	78	15	20	5,190	325.00
20	34	52	28	38	30	3	90	16	24	5,900	375.00
25	36	52	30	40	34	3	96	18	24	6,100	420.00
30	36	52	30	40	34	3	102	18	24	6,400	440.00
35	40	52	34	44	40	3	102	20	30	6,900	500.00
40	40	60	34	44	42	3	120	20	35	8,000	585.00
50	44	64	38	50	48	3	132	22	40	9,750	660.00
60	48	64	42	52	52	3	144	22	45	12,000	800.00

Fixtures comprise Smokestack, Grates, Safety Valve, Gauge Cocks, Steam Gauge, Whistle, Water Gauge, Blow-off, Stop and Check Valves.

All boilers are thoroughly tested with water pressure before leaving the works, and are complete, ready for work.

Further information given upon application.



Single Horizontal Tubular Boilers.

The Single Horizontal Tubular Boiler and setting illustrated above is designed particularly for Mines, Mills, Smelters, etc.

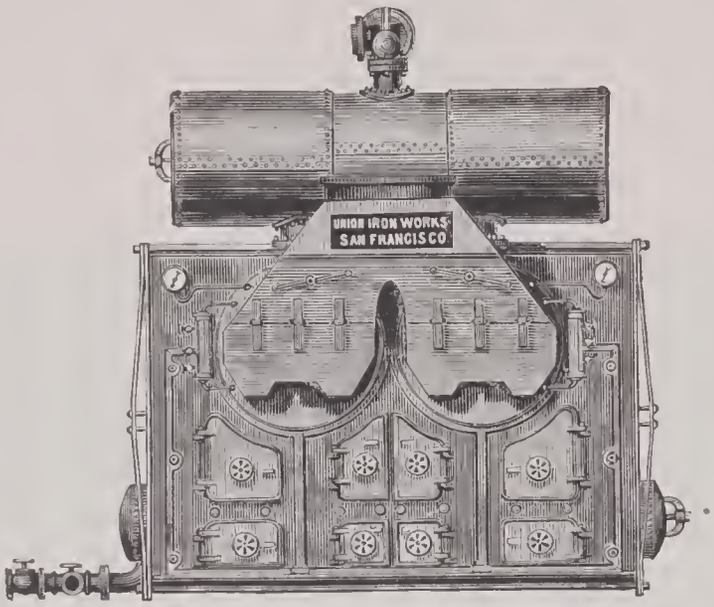
The workmanship and material is of the best quality.

PRICE LIST, WEIGHTS, ETC.

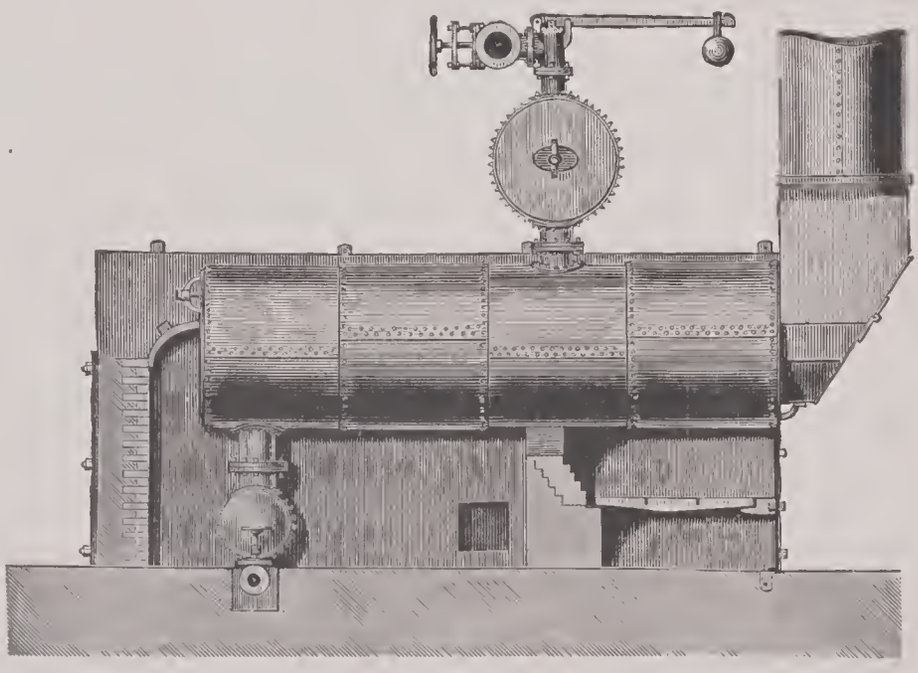
Boiler.			Tubes.			Steam Drum.		Smoke Stack.						Mud Drum.			
Horse-power.	Diameter, inches.	Length, feet.	Number.	Diameter, inches.	Length, feet.	Diameter, inches.	Length, inches.	Diameter, inches.	Height, feet.	Thickness of boiler shell, inches.	Weight of boiler, pounds.	Weight of boiler and fittings, pounds.	Price.	Diameter, inches.	Length, feet.	Weight, pounds.	Price, extra.
24	30	12	18	3	12	20	30	16	35	¼	3,200	6,500	$ 515.00	..	..	....	$.....
26	36	12	28	3	12	24	42	18	35	⅜	3,600	7,880	635.00	..	..	....	.....
30	42	12	38	3	12	30	42	21	40	⅜	4,000	9,100	800.00	..	..	....	.....
40	42	14	38	3	14	30	42	21	40	⅜	5,730	10,800	870 00	18	6½	800	85.00
45	48	14	34	3½	14	30	48	..	40	5/16	6,720	12,000	1,000.00	18	6½	800	85.00
48	48	16	34	3½	16	30	48	24	40	5/16	7,680	13,800	1,080.00	20	6½	900	85.00
60	54	16	44	3½	16	30	48	27	40	5/16	9,120	15,900	1,260.00	20	6½	900	100.00
80	60	16	57	3½	16	30	60	30	40	⅜	11,160	18,600	1,485.00	20	6½	900	100.00

Fixtures comprise breeching, Smokestack and Damper, galvanized wire rope for guys, Fire Front, Grate Bars, Bearing Bars, Arch Flue Plate, Soot Doors and Frame, Boiler Stand or Rest, wrought-iron buck stays and bolts, Safety Valve, Check and Feed Valves, Blow-off Cock, Gauge Columns and Fittings, Gauge Cocks, Glass Water Gauge, Steam Gauge, bolts for all joints.

Further information given upon application.



FRONT VIEW.



SIDE VIEW.

Double Horizontal Tubular Boiler.

INDEPENDENT SETTING.

Double Horizontal Tubular Boilers.

The illustration on the opposite page shows a pair of boilers generally called "double boilers," arranged to run together only. They are connected by large steam drum on top and mud drum on bottom. A double breeching unites both boilers with smokestack.

For sizes and prices see table below.

INDEPENDENT SETTING.

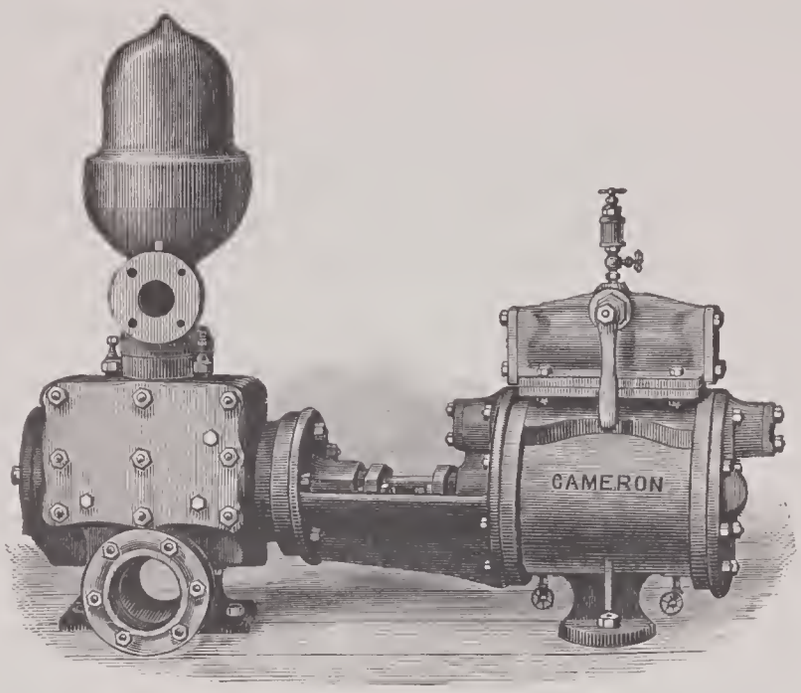
Horse-power.	Size of Boilers.		Tubes.		Steam Drums.		Smoke Stack.		Heating surface, square feet.	Weight of each boiler, pounds.	Total weight, pounds.	Price.	Mud Drum.		Weight of mud drum, pounds.	Price of mud drum.
	Diameter, inches.	Length, feet.	Number.	Diameter, inches.	Diameter, inches.	Length, inches.	Diameter, inches.	Length, feet.					Diameter, inches.	Length feet.		
90	48	14	34	3½	30	48	34	40	1,050	6,720	24,000	....	18	6½	800	....
96	48	16	34	3½	30	48	34	40	1,200	7,680	27,600	....	20	6½	900	....
120	54	16	44	3½	30	48	37	40	1,516	9,120	31,800	....	20	6½	900	....
160	60	16	57	3½	30	60	42	40	1,934	11,160	37,200	....	20	6½	900	....

STANDARD BOILERS SET IN PAIRS.

90	48	14	34	3½	36	8 ft	34	40	1,050	6,720	23,000	....	18	12½	1,600	....
96	48	16	34	3½	36	8 "	34	40	1,200	7,680	26,600	....	20	12½	1,800	....
120	54	16	44	3½	36	10 "	37	40	1,516	9,120	30,800	....	20	13½	2,000	....
160	60	16	57	3½	36	12 "	42	40	1.924	11,160	36,200	....	20	14½	2,200	....

Fixtures comprise breeching, smokestack and damper, galvanized wire rope for guys, fire front, grate bars, bearing bars, arch flue plate, soot doors and frame, boiler stand or rest, wrought-iron buck stays and bolts, safety valve, check and feed valves, blow-off cock, gauge columns and fittings, gauge cocks, glass water gauge, steam gauge, bolts for all joints.

Further information given upon application.



The Cameron Steam Pump.

FOR BOILER FEED, OR GENERAL PUMPING SERVICE—ARRANGED FOR PUMPING HOT OR COLD WATER, OR OTHER FLUIDS.

The illustration above shows the Cameron Pump, designed for general pumping service. The pump cylinders are either plain iron with iron piston rods for pumping fresh cold water, or are arranged with pump linings, pistons, piston rods, valve seats, and stems of best composition.

The pump valves are easily accessible. Its construction permits of using any material for valves to suit liquids of any temperature or consistency.

The water pistons are packed with fibrous packing, and arranged for either hot or cold liquids.

Every pump has suction openings on both sides of pump cylinder, and the discharge outlet can be turned in any direction required.

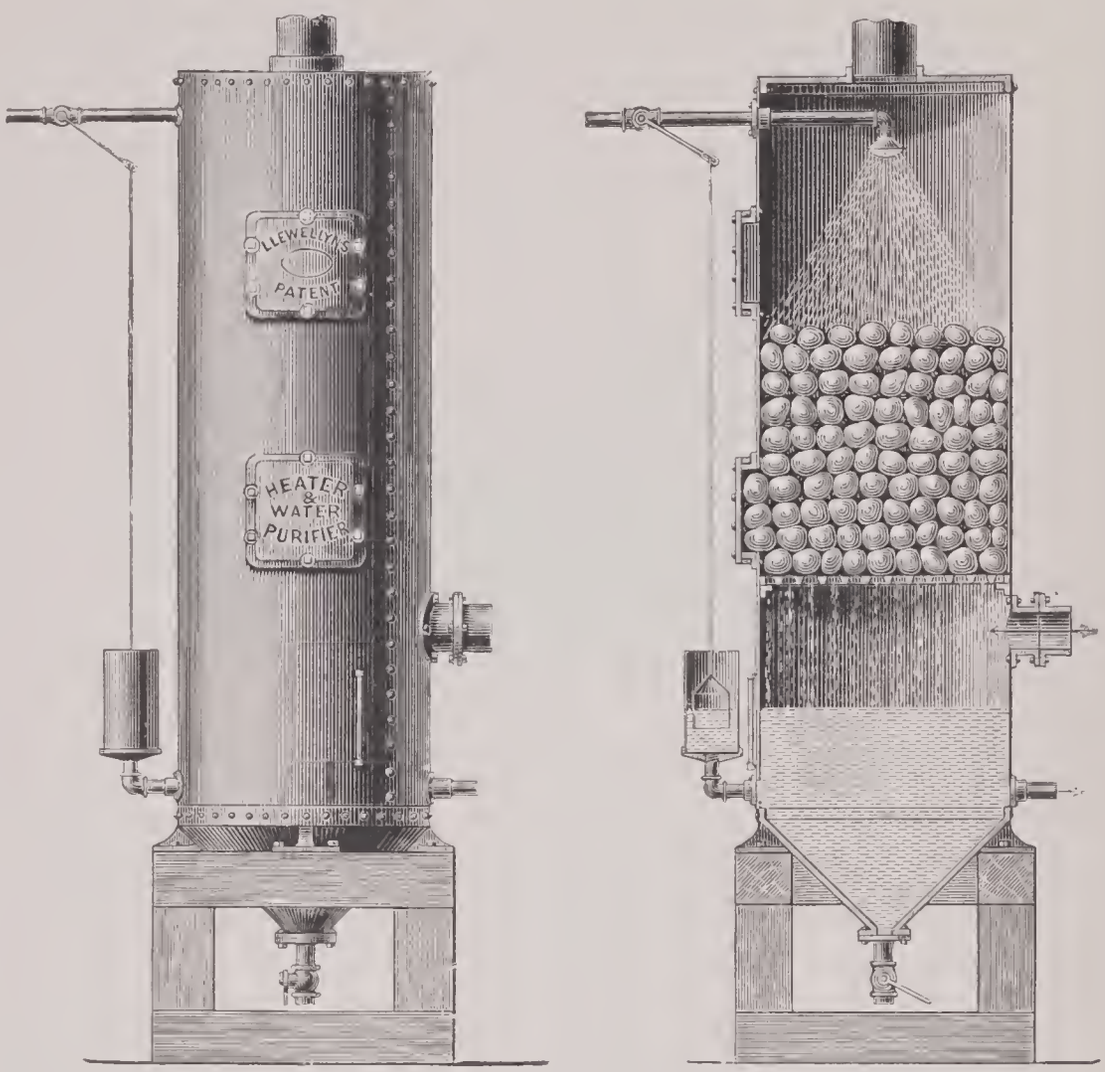
Every pump is thoroughly tested before it leaves the works, and guaranteed to give perfect satisfaction.

First five sizes are made to work by hand when so desired.

Special pump catalogue furnished upon application.

The Cameron Steam Pump.

No.	Diameter of steam cylinder, inches.	Diameter of pump cylinder, inches.	Stroke of piston, inches.	Capacity per stroke, gallons.	Capacity at ordinary speed per minute.	Boilers in horse-power they will supply	Diam. of steam pipe, inches.	Diam. of exhaust pipe, inches.	Diam. of suctiou pipe, inches.	Diam. of discharge pipe, inches.	Weight, pounds.	Price with iron pump, cylinder and piston rod.	Price with pump lining and piston rod of com-position.
0	3½	2	4	.054	8	25	⅜	½	1¼	1	140	$ 80.00	$ 85.00
1	4	2	6	.081	12	40	⅜	½	1¼	1	210	120.00	125.00
2	5	2½	6	.12	20	60	½	¾	1½	1¼	260	140.00	150.00
3	6	3	7	.21	28	100	¾	1	2	1½	426	165.00	175.00
3*a*	6	3½	7	.29	38	140	¾	1	2½	2	435	185.00	200.00
4	7	3½	7	.29	38	140	¾	1	2½	2	482	210.00	225.00
4*a*	7	4	7	.39	50	250	¾	1	2½	2	430	235.00	250.00
5	7	3½	12	5.00	50	....	1	1½	3	2½	833	275.00	290.00
5*b*	7	5	13	1.10	100	....	1	1½	4	3	1,087	325.00	350.00
6	8	4	12	.65	165	....	1	1½	3	2½	1,380	325.00	340.00
6*a*	8	5	13	1.10	100	....	1	1½	4	3	1,090	350.00	375.00
7	10	5	13	1.10	100	....	1¼	2	4	3	1,350	375.00	400.00
8	10	6	13	1.58	150	....	1¼	2	4	3½	1,450	400 00	425.00
9	12	7	13	2.16	200	....	1½	2½	5	4	1,880	470.00	500.00
10*a*	14	8	13	2.83	261	....	2	3	5	5	....	540.00	575.00
10	14	9	18	4.96	325	....	2	3	6	5	....	.....	.....
11	16	10½	18	6.75	450	....	2½	4	8	6	....	.....	.....
12	18	12	20	9.80	587	....	3	4	10	8	....	.....	.....



The Llewellyn Heater.

PRICE LIST, SIZES, WEIGHTS, ETC.

Size No.	Horse-power of engine.	Diameter, feet.	Height, feet.	Weight, pounds.	Price.
1	6	1	5	300	$ 90.00
2	15	1 1/2	6 1/2	460	150.00
3	30	2	7 1/3	680	200.00
4	50	2 1/2	9	1.175	250.00
5	75	3	9	1,510	325.00
6	110	3 1/2	10	2,100	400.00
7	150	4	10	2,700	475.00
8	195	4 1/2	11	3.250	550.00
9	250	5	11	3,750	625.00
10	320	5 1/2	12	4,800	725.00
11	400	6	12	5.650	850.00

The Llewellyn Heater.

The illustrations on the opposite page show the Llewellyn Heater. The utilization of exhaust steam for the purpose of heating feed-water is a very important factor in the economical working of all steam plants, and should receive more attention than is usually given to it. Every degree of heat imparted to the feed-water before it enters into the boiler is just so much saved, not only in cost of fuel, but also in increased capacity of the boiler.

The Llewellyn Heater is very efficient and of simple construction. By referring to the illustration, its operation is easily understood. A cast-iron grating is placed in the shell above the exhaust inlet. Upon this grating is piled a quantity of cobble-stones, ranging from four to six inches in diameter. The steam exhausted from the engine is admitted below, and passes upward through the stones, imparting to them the heat it contains. The feed-water is automatically showered upon the heated stones, passing downward into the reservoir, from which it is pumped into the boiler.

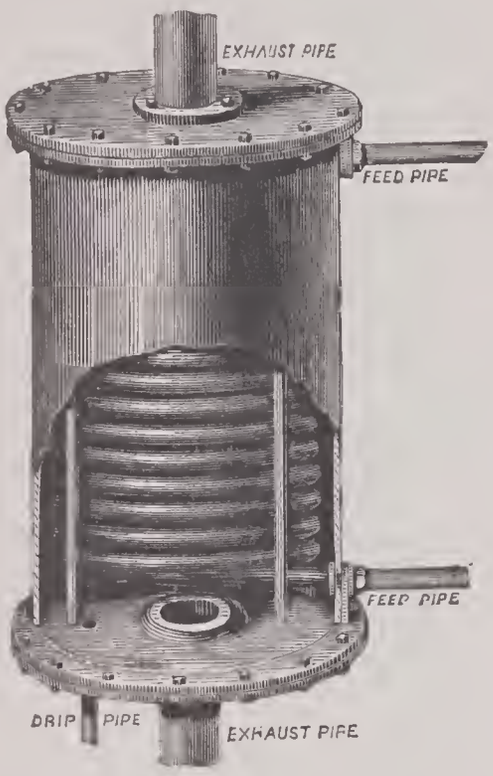
This feed-water heater possesses many valuable features which we desire to call attention to. Regarded simply as a heater, it heats the water nearly *to boiling point,* and automatically controls the quantity of water required for the boiler.

As a purifier it removes most of the impurities from the water before it enters the boiler, thus preventing scale, accomplishing this by heating the water to the degree of temperature necessary to cause the carbonate of lime and other impurities to be precipitated upon the stones before passing into the reservoir, from which it is pumped into the boiler.

As a condenser, more than one-third of the steam admitted to the heater is condensed into pure water, which is returned to the boiler, and assists in loosening and removing old scale, should there be any.

As an "open" heater, it is beyond doubt the simplest and best combination for the purpose in use, and is a valuable adjunct to any steam plant.

The National Brass Coil Heater.



The Heater which we illustrate herewith is one of the recent common-sense improvements in this class of steam appliances. Its simplicity, efficiency and the reasonable price at which it is sold has brought it into very general use.

It consists of a coil or series of coils of seamless drawn brass tubes contained within an iron shell. The feed-water for the boiler passes through this coil, and is heated by the exhaust steam from the engine to boiling point.

In the manufacture of these heaters none but the very best quality of seamless brass tubes are used, and they are tested to 200 pounds pressure before leaving the works.

The National is an absolutely "closed" heater. Leaky joints are wholly obviated by the coil, which is free to expand and contract. The flow of the feed-water to the boiler is perfectly free and easy. It is the best heater made for use in connection with condensing engines, delivering the feed from 150° to 160°, and is no detriment to the vacuum.

PRICE LIST, SIZES, WEIGHTS, ETC.

Number.	Horse-power.	Diameter of feed pipe, inches.	Diameter of exhaust pipe, inch.	Outside dimensions of heater, *Height inch.	Diam. inch.	Weight, pounds.	Price.	Number.	Horse-power.	Diameter of feed pipe, inches.	Diameter of exhaust pipe, inch.	Outside dimensions of heater. *Height inch.	Diam. inch.	Weight, pounds.	Price.
.05	5	½	2	10	7	30	$15	20	200	1½ or 2	8	70	26	1,250	$ 280
1	10	½	2	12	11	50	20	25	250	1½ or 2	8	66	29	1,310	340
1½	15	½	2½	17	16	65	25	30	300	2	8	89	29	1,350	400
2	20	¾	2½	18	19	175	35	40	400	2 or 2½	10	88	36	1,800	500
2½	25	1	3	20	20	250	45	50	500	2 or 2½	10	102	36	2,000	600
3	30	1	4	22	20	330	55	60	600	2½ or 3	12	101	42	2,600	700
4	40	1	4	23	20	375	65	80	800	3	12	110	42	2,800	1,000
5	50	1	4	29	20	420	80	100	1,000	3 or 4	18	117	56	4,750	1,400
6	60	1	4	34	20	455	100	125	1,250	4	18	133	56	5,550	1,600
8	80	1	4	39	20	515	120	150	1,500	4	18	143	56	6,000	2,000
10	100	1 or 1¼	5	56	22	615	140	200	2,000	4½ or 5	18	138	65	6,250	2,500
12	125	1¼ or 1½	5	58	22	655	175	250	2,500	5	18	158	65	6,500	3,000
15	150	1½	8	60	26	1,000	220								

*The heights from No. 10 to No. 250 include legs; no legs below No. 10 uuless ordered.

Sizes 5 to 25 horse-power have exhaust inlet and outlet in top head; sizes 30 horse-power aud over have inlet in bottom and outlet in top heads, unless ordered otherwise.

Size of exhaust varied to suit requirements of engine.

Two or more exhausts in bottom head if necessary.

Steam Pumps

FOR MINING PURPOSES.

In the course of mine development, before sufficient depth has been attained to justify the expense of putting in a "Cornish" system for drainage, the steam pump is generally used, and if properly selected for the work to be performed they give good results both as to duty performed and attendance required.

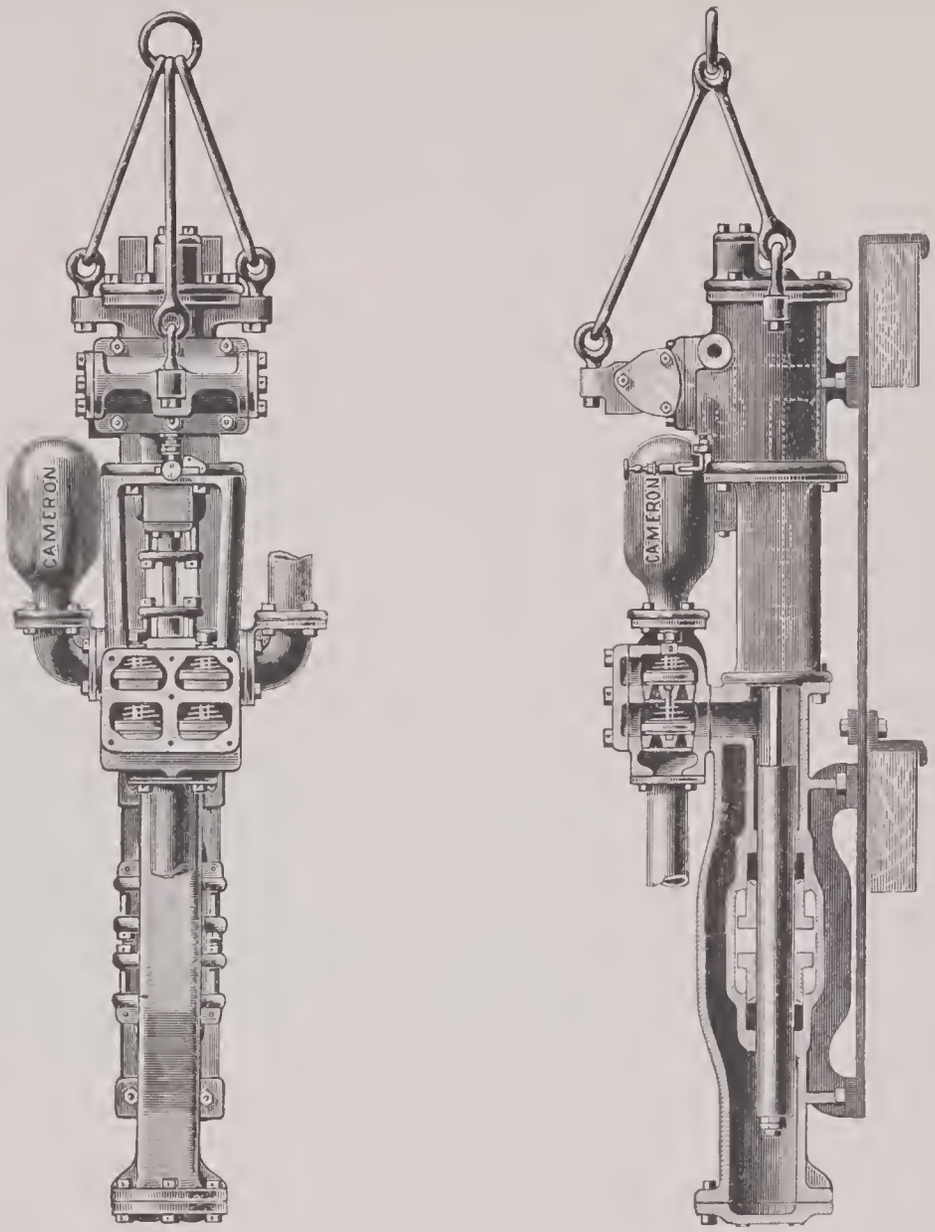
The steam should be carried down the shaft in a well-covered pipe to avoid as much as possible loss from condensation, and the exhaust from the pumps should always be led into a condenser as a measure of economy.

For station pumps an independent condenser and air pump should be employed. For the sinking pumps the exhaust should be led into a suction condenser.

The steam pumps which we illustrate and describe on the following pages can be operated by compressed air as well as by steam, if desired. In localities affording free water power, within a few miles of the mine, compressed air furnishes the most simple and efficient power for pumping.

We make a specialty of the transmission of power by compressed air for underground work, and will be pleased to furnish our patrons with any information on the subject required.

We will also be pleased to give any information desired on the subject of operating pumps by means of electricity. We do not confine ourselves to the special designs and patterns of pumps illustrated, but will furnish plans and specifications with estimates for any duty required.



Vertical Mining Pump.

FOR SINKING AND RECOVERING SHAFTS.

DOUBLE PLUNGER PATTERN.

PRICE LIST, SIZES, ETC.

No.	Steam cylinder. Diam.	Plunger. Diam.	Stroke, in inches	Gallons per min. ordinary piston speed.	Steam pipe, inches.	Exhaust pipe. inches.	Suction pipe, inches.	Discharge pipe, inches.	Dimensions of packages for shipping, inches.	Shipping weight, pounds.	Price.
5	7	3½	12	50	1	1½	2½	2	90 x 22 x 28	1,380	$350.00
6	8	4	12	65	1	1½	3	2½	90 x 22 x 28	1,460	400.00
7	10	5	13	110	1¼	2	4	3	99 x 25 x 38	2,430	475.00
9	12	7	13	216	1½	2½	5	4	102 x 30 x 40	3,450	575.00
9*a*	12	6	13	158	1½	2½	5	4	102 x 30 x 40	3,450	575.00
9*b*	14	7	13	216	2	3	5	4	110 x 33 x 44	4,100	.....
10	14	8	13	293	2	3	6	5	110 x 33 x 44	4,525	.....
11	16	8	16	348	2½	4	6	5	120 x 37 x 48	5,500	.....
12	18	9	16	440	3	4	6	5	120 x 39 x 50	6,100	.....

Prices on larger sizes, or other combinations, furnished upon application.

Vertical Mining Pump.

The illustration on the opposite page shows a vertical mining pump for sinking and recovering shafts. It is of the double plunger pattern, most improved design, is easily handled, and can be placed at an angle or horizontally, and operate perfectly. Being strongly built and very compact, it will withstand rough usage such as machinery of this class is always subjected to.

The pump requires but little room in the shaft. It will throw a steady continuous stream of water and will work equally well when hanging by the tackle or hooked to the shaft timbering.

It is so constructed that the packing can be tightened while operating, or repacked without disturbing any of the connections.

A base plate can be attached to the bottom of the pump cylinder, and the pump used for general purposes after the work in the shaft is completed.

TO CORRESPONDENTS.

In ordering or corresponding in regard to steam pumps, it should be borne in mind that the successful application of a pump depends greatly upon its proper selection from a variety of patterns, arranged for various purposes, which we have designed to meet the wants of purchasers.

It is, therefore, to the interest of our patrons that we should be informed on the following points:

1. For what purpose is the pump to be used?
2. What kind of liquid to be pumped? and if fresh, salt or acidulous, hot or cold, clear or gritty?
3. What height is the liquid to be lifted by suction? also, diameter and length of suction pipe, with the number of elbows or bends?
4. To what height, or against what pressure, is the liquid to be forced? Give diameter and length of delivery pipe.
5. What is the maximum quantity to be forced per minute or hour?
6. What is the pressure of steam used?

For further information send for our Special Pump Catalogue.

Compound Sinking Pump.

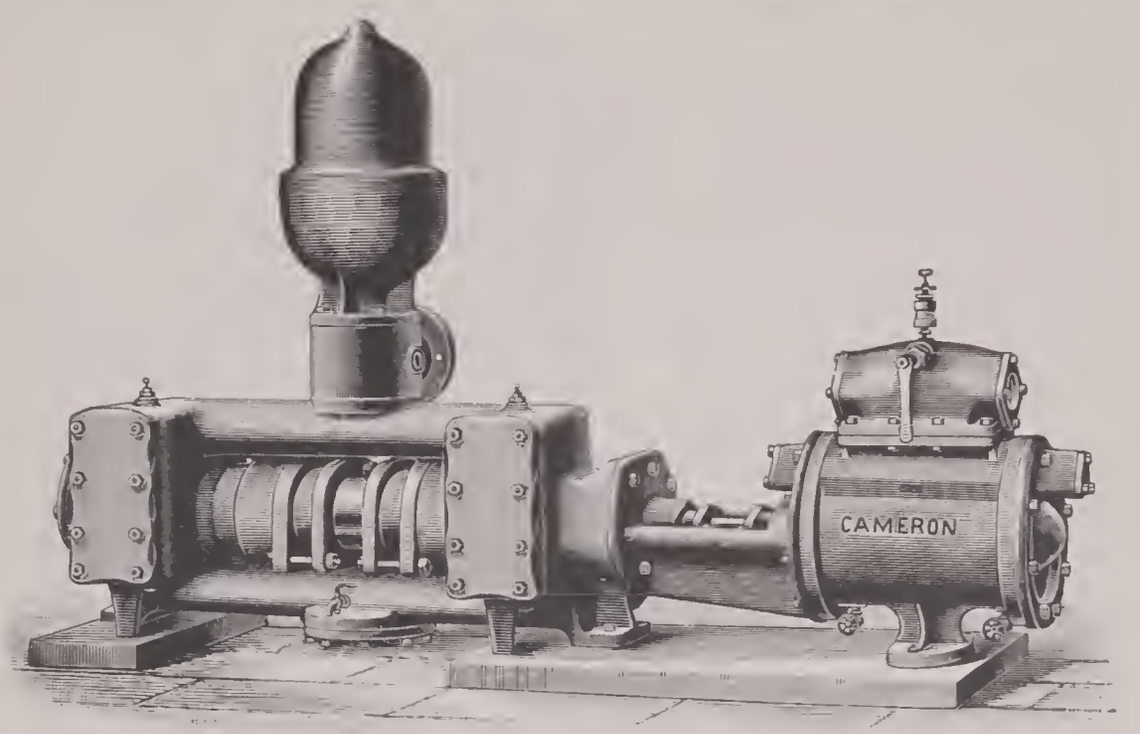
ACTUATED BY AIR.

The Compound Vertical Mining (or Sinking) Pump illustrated herewith is intended particularly for use with compressed air, as the arrangement of cylinders admits of the air being used expansively, insuring a high degree of economy.

This pump is designed for hard usage and severe and continuous duty. It will work equally well at any angle, or in either a vertical or horizontal position, and particular attention is called to the accessibility and simplicity of all parts. It is made, either as shown, with bucket plunger, or with outside packed, differential plunger, and is an economical, efficient and thoroughly reliable machine.

These pumps are not kept in stock, but are built to suit the varying conditions of lift and steam or air pressure.

Further particulars, prices, etc., given on application.



The Cameron Double Plunger Pumps.

The illustration above shows a Cameron Double Plunger Pump, especially designed for feeding boilers with hot or cold water, under heavy pressure. They are extensively used in rolling mills, blast furnaces, etc., and have entirely superseded the expensive and cumbersome fly-wheel pumps, formerly so commonly in use for that purpose. They are also adapted for pumping water mixed with sand or grit. They are more compact than any other make of plunger pumps; there are no outside connections, and, the plunger resting in the stuffing boxes in the center, there is no liability of its sagging.

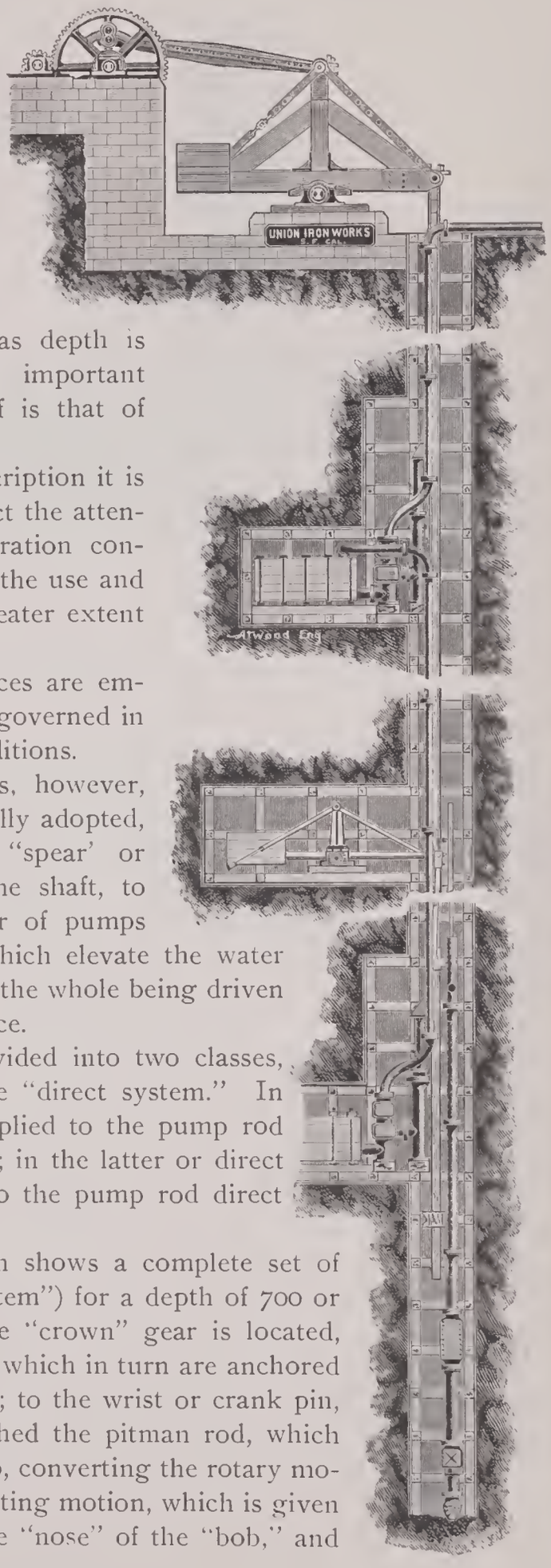
The valve arrangement is similar to the regular piston pump. The water valve seats are made of the best composition. Valves of material to best suit the situation. Piston rods of steel with iron plungers, or rods and plungers of best composition, as circumstances require.

PRICE LIST, SIZES, ETC.

Pumps.	Diameter of steam cylinder.	Diameter of plunger.	Stroke in inches.	Capacity at ordinary speed, per minute.	Boilers in horse-power they will supply.	Steam pipe.	Exhaust pipe.	Suction pipe.	Discharge pipe.	Floor space required, inches.	Weight.	Price, all iron.	Price, with composition piston rod.	Price, with composition piston rods and plungers.
A	4	2	6	12	40	⅜	½	1¼	1	53 x 10	....	$125.00	$128.00	$150.00
B	6	3	7	28	100	¾	1	2	1⅓	59 x 13	....	220.00	225.00	250.00
B B	7	3½	7	38	140	¾	1	2	1½	60 x 15	....	270.00	275.00	300.00
C	8	4	12	65	260	1	1½	3	2½	82 x 18	....	375.00	385.00	425.00
D	10	5	13	100	400	1¼	2	4	3	91 x 23	....	450.00	460.00	500.00
E	12	6	18	150	600	1½	2½	5	4	114 x 25	....			
E E	12	7	13	200	...	1½	2½	5	4	99 x 27	....			
F	14	8	18	260	...	2	3	6	5	126 x 29	....			
G	14	7	18	200	...	2	3	5	4	126 x 28	....			
H	16	8	18	260	...	2½	4	6	5	130 x 30	....			

For further information send for our special Pump Catalogue.

PUMPING MACHINERY.



In mine development, as depth is attained, one of the most important problems that presents itself is that of drainage.

In a circular of this description it is impossible to give this subject the attention it deserves, as no operation connected with mining involves the use and application of power to a greater extent than that of handling water.

Many systems and devices are employed, their selection being governed in many instances by local conditions.

For ordinary conditions, however, the "Cornish system" is usually adopted, which consists of a timber "spear' or pump rod running down the shaft, to which is attached a number of pumps located at different levels, which elevate the water in lifts from one to the other, the whole being driven by power located on the surface.

This system may be divided into two classes, the "geared system" and the "direct system." In the former the power is applied to the pump rod through a system of gearing; in the latter or direct system motion is imparted to the pump rod direct from the engine.

The illustration herewith shows a complete set of Cornish Pumps ("geared system") for a depth of 700 or 800 feet. At the surface the "crown" gear is located, attached to heavy sole plates, which in turn are anchored to massive stone foundations; to the wrist or crank pin, secured to the gear, is attached the pitman rod, which connects with the balance bob, converting the rotary motion of the gear into reciprocating motion, which is given the pump rod attached to the "nose" of the "bob," and

which passes down the shaft below the last station or No. 2. To this rod are attached the three pumps shown. The pump at the bottom of the shaft is called the sinking or lift pump, which lifts the water from the bottom of the shaft or "sump" into the tank located at Station No. 2. From this tank the station pump, which is a plunger force pump, takes the water and forces it up 300 feet and discharges it into a tank located at Station No. 1. Here, again, the process is repeated until the water is finally discharged at the surface. Intermediate between the two pump stations is located an underground balance "bob." This, with the main "bob" at the surface, is weighted until the power required is balanced, that is, the "in stroke" and "out stroke" requiring the same power, thus insuring a steady motion to all the parts.

The pumps nearest the surface are usually larger than those lower down, as in most instances all the levels produce more or less water, which is caught up and conveyed to the nearest tank below.

In many instances, while the shaft is being put down, that is, active sinking operations going on, the lift pump is dispensed with, owing to its being heavy and cumbersome to handle, and a steam pump is employed in its stead, which is easier to handle, takes up less room and permits drier work. This pump is often operated by compressed air.

The power for operating this system can be applied by means of a steam engine, water power or electricity. Many of the mines of California employ water power for this purpose.

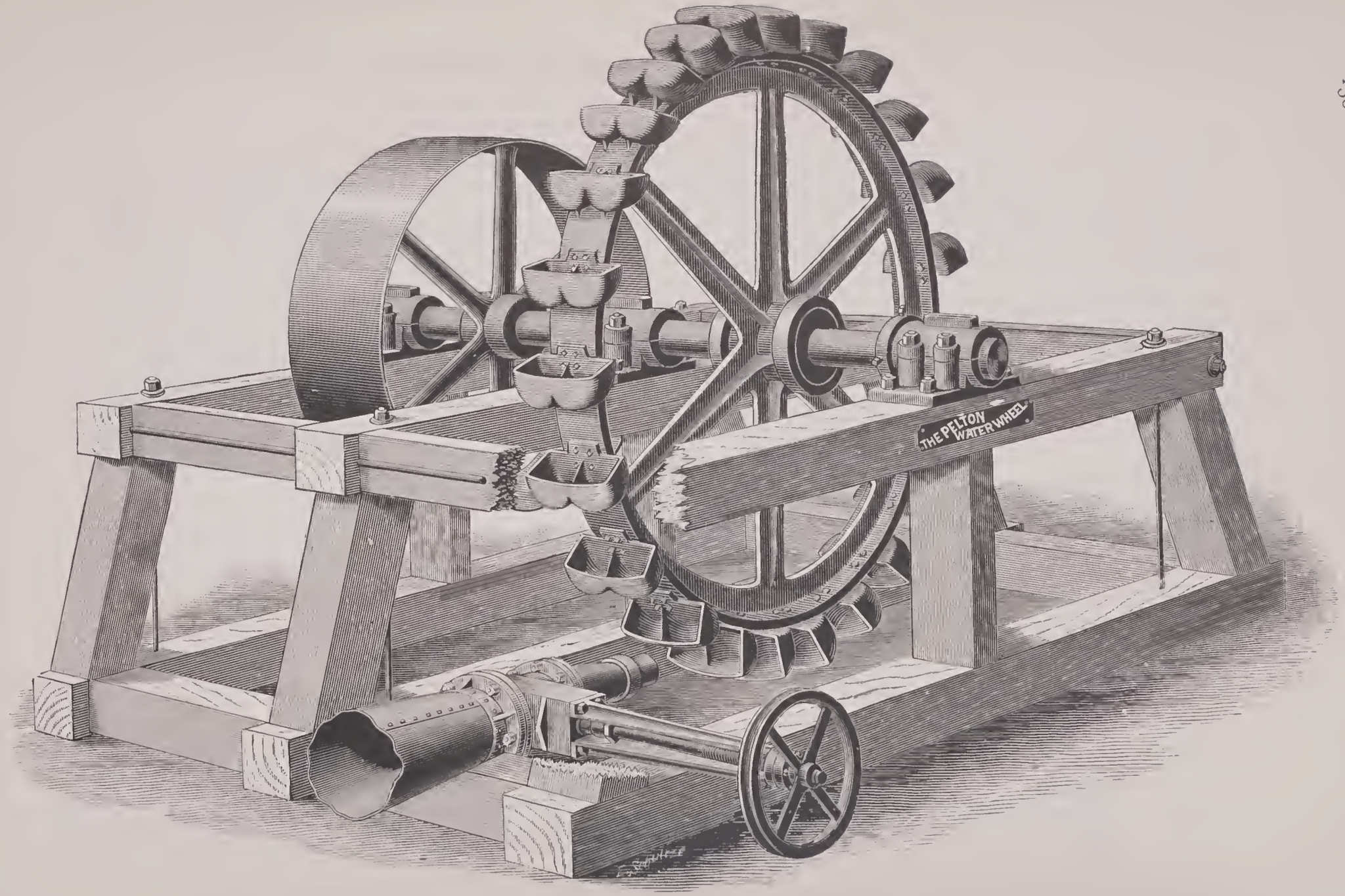
The "geared system" is not adapted to great depths, as all the strains due to the great weight of the rods and their accelerating and retarding motion must center upon the wrist pin secured to the arm of the crown gear, located at the head of the shaft, thus requiring large pumps run at a moderate rate of speed.

For deep mining the "direct system" possesses many advantages over the "geared system," and is always employed where great depth and large quantities of water have to be dealt with; and especially is this true where the character of the work has to be of a permanent nature.

While it is generally conceded that, wherever fuel has to be employed for generating the power required for pumping, the "Cornish system" is the most economical as to duty performed; yet, with the advent of electricity and the improved appliances for compressing air, the ease and facility with which power can be transmitted by both render the selection of a system for handling large or small quantities of water, lesser or greater depths, a matter that can only be determined by considering the conditions governing each particular case.

We have had a large and varied experience in this class of machinery, having built some of the largest pumping plants in this country, and our knowledge on this subject is always at the service of our patrons.

Plans, specifications and estimates furnished upon application for any duty required.



Standard Pelton Water Wheel Mounted on Wooden Frame.

The Pelton Water Wheel.

The illustration on the opposite page shows a standard Pelton Water Wheel, mounted on wooden frame. This wheel is so well known to the public that it is useless to go into a description of same here.

The power of the Pelton Wheel does not depend upon its diameter, but upon the head and the amount of water applied to it. Where a very considerable amount of power is wanted under a comparatively low head, a wheel of larger diameter is necessary to admit of buckets of corresponding capacity, as also the application of two or more nozzles for the purpose of multiplying power.

Wheels as large as from twelve to sixteen and twenty feet in diameter are sometimes made for the purpose of direct connection with crank shafts of pumps, compressors, etc. Small buckets are frequently used on wheels of large diameter for purpose of reducing speed where operating under high heads and running slow-speed machinery.

Where wheels of standard sizes do not meet the requirements of any particular case, special wheels can be made to suit the conditions presented. The velocity of the wheel being determined by the water head or pressure, the diameter can be made to conform to the speed required, and the buckets and nozzles proportioned to amount of water available and the power wanted, a special adaptation being thus made as far as possible in each case to the conditions under which the wheel is to work.

The facility with which such adaptation can be made to all varying conditions is one of the marked and distinguishing features of the Pelton Wheel, and admits of application to a great variety of service in the most simple, economical and efficient way.

When more than one nozzle is used, it is for the purpose of increasing the power by applying more water, or for securing a higher speed than can be obtained from a larger wheel with a single nozzle. By using multiple nozzles sufficient power can be obtained from a wheel of small diameter to admit of direct connection to shaft of dynamo or other high-speed machinery without intermediate gearing, or of giving such increase of speed as to admit of belting direct without the use of countershafting and pulleys.

See page 140 for price list, weights, etc.

The Pelton Water Wheel.

PRICE LIST, STANDARD SIZES, ETC.

Head in feet.	18 inch wheel.	2 foot wheel.	3 foot wheel.	4 foot wheel.	5 foot wheel.	6 foot wheel.	7 foot wheel.	8 foot wheel.	10 foot wheel.	12 foot wheel.
50	$115	$150	$210	$275	$350	$400	$ 450	$ 500	$ 750	$1,250
100	120	160	230	290	375	425	475	550	850	1,400
150	125	170	240	310	390	450	500	600	975	1,600
200	130	175	250	340	410	475	525	650	1,100	1,750
250	135	180	275	360	440	525	575	675	1,200	1,900
300	140	185	290	390	475	600	650	750	1,275	2,100
350	150	200	310	410	540	675	725	825	1,375	2,250
400	160	210	330	450	600	775	850	950	1,500	2,500
450	175	225	350	475	650	875	950	1,100	1,750	3,000
500	200	250	375	525	725	950	1,025	1,250	2,000	3,500
	Weight 300 to 500 lbs.	Weight 450 to 800 lbs.	Weight 750 to 1,100 lbs.	Weight 1,100 to 1,800 lbs.	Weight 1,600 to 2,300 lbs.	Weight 2,400 to 3,100 lbs.	Weight 3,200 to 4,000 lbs.	Weight 4,100 to 5,000 lbs.	Weight 6,000 to 8,000 lbs.	Weight 8,000 to 12,000 lbs.

FOR HORSE-POWERS UNDER THE VARIOUS HEADS SEE TABLES.

NOTE.—The above prices are *net cash*, not subject to discount, and are for Standard Wheels, to be mounted on Wood Frames, as shown. They include Shaft, Boxes, Collars, Key, Nozzle and Gate, with three interchangeable nozzle-tips to give variation of power if required. Driving pulleys are not included, as the various requirements make this impracticable. They are *extra*, but will be furnished of such size as required at regular prices.

For wheels using two or more nozzles, or for special wheels to work under higher heads, prices will be quoted upon application.

DATA REQUIRED FOR ESTIMATES.

Correspondents applying for information should give the following data, or as much thereof as applies to their case:

First—Amount of water available, either in miner's inches or flow per minute in gallons or cubic feet. If in miner's inches, give the size of the aperture in the measuring box and the head above the center of same. When the water supply varies at different seasons, give the smallest and largest amount, with a general average, and state if it is desired to have the wheel of capacity to utilize the full amount.

Second—Head or vertical fall of water from ditch, flume or other source of supply to the point where wheel is to be located, with accuracy, if possible; otherwise approximately,

Third—Length and diameter of pipe line conveying water to wheel. If not already laid, consult tables as to proper size or write for information, giving full particulars as to length, and such other data as is called for herein.

Fourth—Horse-power required and what it is designed to run. If for quartz mill, give the number and weight of stamps, and lift and drop per minute. Also describe in detail any other machinery it is proposed to run, with speed, etc. If for dynamos, give capacity and speed, and whether for power or light, distance of transmission, etc.

Fifth—For pumping give amount of water to be raised and vertical depth. For hoisting give weight of cage, car and cable, as also load it is desired to carry, together with the vertical height, speed, etc.

Sixth—Where the size of flume or ditch is given, showing volume of water, give in all cases the velocity of the current, or the grade on which the flume is laid.

Seventh—Do not give as water supply an amount that will fill a certain sized pipe, calculations based upon such information being difficult and unreliable.

Eighth—With order, the fall or effective head, as also the horse-power the wheel is intended to develop, should be given with as much accuracy as possible. Wheels in no cases furnished without gate and nozzle, these being necessary to make a proper application of the stream to the wheel.

For further information see Catalogue No. 1.

Tables for Calculating the Horse-power of Water.

MINER'S INCH TABLE.

The following table gives the Horse-power of one miner's inch of water under heads from one up to eleven hundred feet. This equals 1½ cubic feet per minute.

Heads in feet.	Horse-power.	Heads in feet.	Horse-power.
1	.0024147	320	.772704
20	.0482294	330	.796851
30	.072441	340	.820998
40	.096588	350	.845145
50	.120735	360	.869292
60	.144882	370	.893439
70	.169029	380	.917586
80	.193176	390	.941733
90	.217323	400	.965880
100	.241470	410	.990027
110	.265617	420	1.014174
120	.289764	430	1.038321
130	.313911	440	1.062468
140	.338058	450	1.086615
150	.362205	460	1.110762
160	.386352	470	1.134909
170	.410499	480	1.159056
180	.434646	490	1.183206
190	.458793	500	1.207350
200	.482940	520	1.255644
210	.507087	540	1.303938
220	.531234	560	1.352232
230	.555381	580	1.400526
240	.579528	600	1.448820
250	.603675	650	1.569555
260	.627822	700	1.690290
270	.651969	750	1.811025
280	.676116	800	1.931760
290	.700263	900	2.173230
300	.724410	1,000	2.414700
310	.748557	1,100	2.656170

CUBIC FEET TABLE.

The following table gives the Horse-power of one cubic foot of water per minute under heads from one up to eleven hundred feet:

Heads in feet.	Horse-power.	Heads in feet.	Horse-power.
1	.0016098	320	.515136
20	.032196	330	.531234
30	.048294	340	.547332
40	.064392	350	.563430
50	.080490	360	.579528
60	.096588	370	.595626
70	.112686	380	.611724
80	.128784	390	.627822
90	.144892	400	.643920
100	.160980	410	.660018
110	.177078	420	.676116
120	.193176	430	.692214
130	.209274	440	.708312
140	.225372	450	.724410
150	.241470	460	.740508
160	.257568	470	.756606
170	.273666	480	.772704
180	.289764	490	.788802
190	.305862	500	.804900
200	.321960	520	837096
210	.338058	540	.869292
220	.354156	560	.901488
230	.370254	580	.933684
240	.386352	600	.965880
250	.402450	650	1.046370
260	.418548	700	1.126860
270	.434646	750	1.207350
280	.450744	800	1.287840
290	.466842	900	1.448820
300	.482940	1,000	1 609800
310	.499038	1,100	1.770780

WHEN THE EXACT HEAD IS FOUND IN ABOVE TABLE.

EXAMPLE.—Have 100 foot head and 50 inches of water. How many Horse-power?

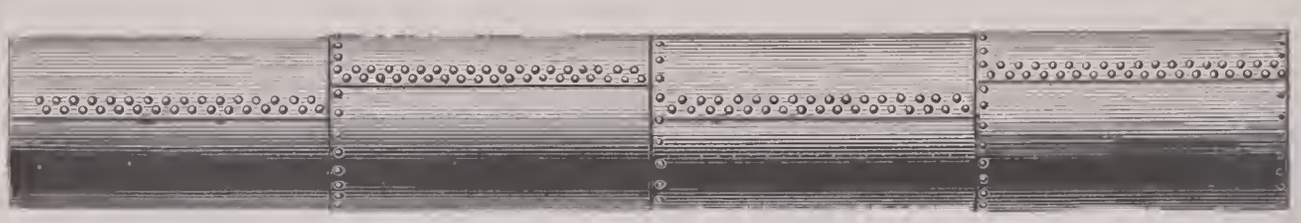
By reference to above table the Horse-power of 1 inch under 100 foot head is .241470. This amount multiplied by the number of inches, 50, will give 12.07 Horse-power.

WHEN EXACT HEAD IS NOT FOUND IN TABLE.

Take the Horse-power of 1 inch under 1 foot head, and multiply by the number of inches, and then by number of feet head. The product will be the required Horse-power.

The above formula will answer for the cubic feet table, by substituting the equivalents therein for those of miner's inches.

NOTE.—The above tables are based upon an efficiency of 85%.



Hydraulic Pipe.

The question of water conduit is everywhere one of so much importance and is so intimately connected with the utilization of power by the water wheel, that special consideration is given to it in this connection. The use of sheet-iron pipe for hydraulic purposes and for power is strictly of California origin, and, though so extensively adopted in the Pacific Coast States, its advantages may be said to be very imperfectly understood in other parts of the country.

The general impression among engineers, who have not made this subject a special study, being, that heavy, cast-iron pipe, or lap-weld tubing is necessary to carry any considerable pressure, or for any degree of permanency. This prejudice has arisen in part from the fact that sheet-iron pipe, when first used, was only painted on the outside, which proved ineffectual to prevent corrosion, so that from eight to ten years generally covered the extreme limit of service of pipe so laid.

The plan then adopted of coating with a preparation of asphalt, both inside and out, proved so successful that it has been extensively used under every variety of condition as to pressure, diameter and thickness of iron, with the result that a comparatively light iron, in pipe of moderate diameter, will stand a much higher head than is generally supposed, while, with a proper adaptation to diameter and pressure, it is not only much cheaper, but will meet every requirement more satisfactorily than any other kind of pipe made.

What is termed the slip joint, illustrated above, is ordinarily used, excepting in pipe of large diameter, or under very high head. In laying such pipe, where the lengths come together at an angle, a lead joint should be made. This is done by putting on a sleeve, allowing a space say three-eighths of an inch for running in lead. With a heavy pressure, and expressly on steep grades, the lengths should be wired together, lugs being put on the sections forming the joints for this purpose, and, where the grade is very steep, the pipe should be securely anchored with wire cable.

Table of Sheet-iron Hydraulic Pipe.

Diameter of pipe in inches.	Area of pipe in inches.	Thickness of iron (wire gauge).	Head in feet pipe will stand with safety.	Cubic feet of water pipe will convey per min., 3 feet velocity per second.	Weight per foot in pounds.	Price, per foot.
3	7	18	400	9	2	$ .20
4	12	18	350	16	2¼	.25
4	12	16	525	16	3	.35
5	20	18	325	25	3½	.35
5	20	16	500	25	4¼	.45
5	20	14	675	25	5	.50
6	28	18	296	36	4¼	.44
6	28	16	487	36	5¾	.50
6	28	14	743	36	7½	.56
7	38	18	254	50	5¼	.50
7	38	16	419	50	6¾	.56
7	38	14	640	50	8½	.63
8	50	16	367	63	7½	.65
8	50	14	560	63	9½	.75
8	50	12	854	63	13	.94
9	63	16	327	80	8½	.69
9	63	14	499	80	10¾	.88
9	63	12	761	80	14¼	1.06
10	78	16	295	100	9¼	.72
10	78	14	450	100	11¾	.82
10	78	12	687	100	15¾	1.00
10	78	11	754	100	17½	1.25
10	78	10	900	100	19¼	1.50
11	95	16	269	120	9¾	.75
11	95	14	412	120	13	.94
11	95	12	626	120	17¼	1.25
11	95	11	687	120	18¾	1.44
11	95	10	820	120	21	1.62
12	113	16	246	142	11¼	.82
12	113	14	377	142	14	1.00
12	113	12	574	142	18½	1.38
12	113	11	630	142	19¾	1.50
12	113	10	753	142	22¾	1.69
13	132	16	228	170	12	.90
13	132	14	348	170	15	1.12
13	132	12	530	170	20	1.50
13	132	11	583	170	22	1.65
13	132	10	696	170	24½	1.80
14	153	16	211	200	13	.98
14	153	14	324	200	16	1.17
14	153	12	494	200	21½	1.57
14	153	11	543	200	23½	1.72
14	153	10	648	200	26	1.95
15	176	16	197	225	13¾	.96
15	176	14	302	225	17	1.28
15	176	12	460	225	23	1.75
15	176	11	507	225	24½	1.95
15	176	10	606	225	28	2.10
16	201	16	185	255	14½	1.05
16	201	14	283	255	17¼	1.20
16	201	12	432	255	24¼	1.70
16	201	11	474	255	26½	1.85
16	201	10	567	255	29½	2.00
18	254	16	165	320	16½	$ 1.20
18	254	14	252	320	20½	1.40
18	254	12	385	320	27¼	1.90
18	254	11	424	320	30	2.10
18	254	10	505	320	34	2.40
20	314	16	148	400	18	1.26
20	314	14	227	400	22½	1.54
20	314	12	346	400	30	2.10
20	314	11	380	400	32½	2.25
20	314	10	456	400	36½	2.50
22	380	16	135	480	20	1.40
22	380	14	206	480	24¾	1.70
22	380	12	316	480	32¾	2.25
22	380	11	347	480	35¾	2.45
22	380	10	415	480	40	2.80
24	452	14	188	570	27¼	1.80
24	452	12	290	570	35½	2.35
24	452	11	318	570	39	2.70
24	452	10	379	570	43½	2.95
24	452	8	466	570	53	3.50
26	530	14	175	670	29¼	2.00
26	530	12	267	670	38½	2.59
26	530	11	294	670	42	2.87
26	530	10	352	670	47	3.10
26	530	8	432	670	57¼	3.85
28	615	14	102	775	31¼	2.12
28	615	12	247	775	41¼	2.75
28	615	11	273	775	45	3.00
28	615	10	327	775	50¼	3.20
28	615	8	400	775	61¼	4.15
30	706	12	231	890	44	2.90
30	706	11	254	890	48	3.15
30	706	10	304	890	54	3.50
30	706	8	375	890	65	4.30
30	706	7	425	890	74	4.75
36	1017	11	141	1300	58	3.80
36	1017	10	155	1300	67	4.30
36	1017	8	192	1300	78	5.10
36	1017	7	210	1300	88	5.75
40	1256	10	141	1600	71	4.75
40	1256	8	174	1600	86	5.60
40	1256	7	189	1600	97	6.40
40	1256	6	213	1600	108	7.35
40	1256	4	250	1600	126	8.50
42	1385	10	135	1760	74½	5.05
42	1385	8	165	1760	91	6.20
42	1385	7	180	1760	102	7.00
42	1385	6	210	1760	114	7.80
42	1385	4	240	1760	133	9.00
42	1385	¼	270	1760	137	9.50
42	1385	3	300	1760	145	10.00
42	1385	5/16	321	1760	177	12.00
42	1385	⅜	363	1760	216	15.00

NOTE.—The prices quoted here are to assist intending purchasers to make an approximate estimate of cost. Net prices will be quoted upon application.

Capacity of Ditches

IN MINER'S INCHES.

Width at top.....	2.2 ft.	3.3 ft.	4.4 ft.	5.5 ft.	6.6 ft.	7.7 ft.	8.8 ft.
Width at bottom.	1.5 "	1.5 "	2.0 "	2.5 "	3.0 "	3.5 "	4.0 "
Depth of stream.	0.8 "	1.2 "	1.6 "	2.0 "	2.4 "	2.8 "	3.2 "
Area of section...	1.28 sq.ft.	2.88 sq.ft.	5.12 sq. ft.	8.0 sq. ft.	11.52 sq. ft.	15.68 sq. ft.	20.48 sq. ft.
FALL							
Per mile, feet.	Per rod, inches.	Capacity, miner's inches.	Capacity, miner's inches.	Capacity, miner's inches.	Capacity, miner's inches.	Capacity, miner's inches.	Capacity, miner's inches.	Capacity, miner's inches.
1	0.036	22	61	133	278	452	673	1,013
2	.073	31	94	193	394	640	952	1,432
3	.109	38	115	237	482	783	1,166	1,754
4	.145	44	132	273	557	926	1,346	2,025
5	.182	50	148	306	623	1,012	1,505	2,265
6	.219	54	162	335	682	1,108	1,649	2,481
7	.254	59	171	362	737	1,197	1,781	2,679
8	.291	63	187	386	787	1,280	1,904	2,864
9	.327	67	199	410	835	1,357	2,019	3,038
10	.364	70	209	432	880	1,431	2,128	3,202
11	.401	74	220	453	923	1,501	2,232	3,359
12	.436	77	230	474	965	1,567	2,332	3,532
13	.476	80	239	493	1,004	1,631	2,427	3,651
14	.509	83	248	512	1,042	1,693	2,519	3,789
15	.545	86	257	530	1,078	1,752	2,607	3.922
16	.582	89	265	547	1,113	1,810	2,693	4,051
17	.618	92	273	564	1,148	1,865	2,775	4,175
18	.654	94	281	580	1,181	1,919	2,855	4,296
19	.691	97	289	596	1,214	1,972	2,929	4,414
20	.727	100	296	611	1,245	2,023	3,010	4,529
21	.763	102	304	627	1,276	2,073	3,085	4,641
22	.800	104	311	641	1,306	2,122	3,157	4,750
23	.836	107	318	656	1,335	2,170	3,228	4,857
24	.873	109	325	670	1,364	2,217	3,297	4,961
25	.909	111	331	684	1,399	2,262	3,366	5,064

Power Required.

For Different Parts of Gold Mills.

Each 750-pound Stamp, dropping 100 times per minute, requires 1.5 horse-power.

Each 800-pound Stamp, dropping 100 times per minute, requires 1.6 horse-power.

Each 850-pound Stamp, dropping 100 times per minute, requires 1.8 horse-power.

Each 900-pound Stamp, dropping 100 times per minute, requires 1.9 horse-power.

Each 950-pound Stamp, dropping 100 times per minute, requires 2.0 horse-power.

Each 1000-pound Stamp, dropping 100 times per minute, requires 2.1 horse-power.

Each 1050-pound Stamp, dropping 100 times per minute, requires 2.2 horse-power.

Each 1100-pound Stamp, dropping 100 times per minute, requires 2.3 horse-power.

Each 1200-pound Stamp, dropping 100 times per minute, requires 2.4 horse-power.

Each 1300-pound Stamp, dropping 100 times per minute, requires 2.6 horse-power.

Each 1350 pound Stamp, dropping 100 times per minute, requires 2.7 horse-power.

Each 4 x 4-inch Dodge Crusher requires 1 horse-power.
Each 6 x 6-inch Dodge Crusher requires 3 horse-power.
Each 7 x 8-inch Dodge Crusher requires 5 horse-power.
Each 8 x 12-inch Dodge Crusher requires 7 horse-power.
Each 6 x 9-inch Union Crusher requires from 4 to 6 horse-power.
Each 8 x 12-inch Union Crusher requires from 6 to 8 horse-power.
Each 10 x 16-inch Union Crusher requires from 10 to 15 horse-power.
Each Union Concentrator, 4 feet, requires ¾ horse-power.
Each Union Concentrator, 6 feet, requires 1 horse-power.

Each 48-inch Clean-up Pan, 30 revolutions per minute, requires 1.5 horse-power.

Each 5-foot Combination Pan, 65 revolutions per minute, requires from 5 to 10 horse-power.

Each 4-foot Combination Pan, 65 revolutions per minute, requires from 3 to 6 horse-power.

Each 8-foot Settler, 14 revolutions per minute, requires 2.5 horse-power.
Each 8-foot Agitator, 16 revolutions per minute, requires 3 horse-power.
Each Quicksilver Elevator requires from .25 to 2 horse-power.
Each Revolving Dryer requires 5 horse-power.
Each Howell-White Roasting Furnace requires from 4 to 6 horse-power.
Each Brückner Furnace, 8 x 18 feet, requires from 5 to 8 horse-power.

Above estimates include the friction of the parts named, but not that of the power transmitting machinery, for which an additional allowance should be made.

WATER REQUIRED

For Various Parts of Gold Mills.

Boiler feed for each horse-power, per hour, 5 gallons.
For each stamp, per hour, from 60 to 80 gallons.
For each 5-foot Pan, per hour, 100 gallons.
For each 8-foot Settler, per hour, 80 gallons.
For each Concentrator, per hour, from 200 to 300 gallons.

When water is settled and returned to the mill for re-use, a reduction of 50 per cent may be safely estimated for all except the boiler, which must have clear water.

Quicksilver evaporates slightly at ordinary temperature and boils at 662°. Its specific gravity is 13.6 at 32° F.

2.035 cubic inches weigh 1 pound.

1 cubic foot weighs 849 pounds at 32° F.

In a column of quicksilver every foot in height gives a pressure of 5.895 pounds per square inch. That quicksilver will pass through a smaller aperture than water is a popular fallacy naturally deducted from the fact that the former will often leak from a vessel that will hold the latter. An explanation for this seeming paradox is that quicksilver, being so much heavier, gives far greater pressure, and, in wooden vessels, water having the finer penetration, enters the fiber of the wood and swells it, thereby closing small openings, whereas quicksilver entering only the open grain has no expanding effect.

Gold melts at 2016°, its specific gravity is 19.3.

Silver melts at 1873°, its specific gravity is 10.5.

Copper melts at 1996°, its specific gravity is 8.9.

Cast iron melts at 2786°, its specific gravity is 7.2.

Lead melts at 612°, its specific gravity is 11.3.

MEASURES AND WEIGHTS OF ORES, EARTH, ETC.

13 cubic feet of ordinary gold or silver ore, in mine = 1 ton = 2000 pounds.
20 cubic feet of broken quartz..... = 1 ton = 2000 pounds.

In calculating the quantity of ore in place in a mine, an allowance is generally made for moisture in the ore, determined by the character of the ore.

18 feet of gravel in bank..... = 1 ton.
27 cubic feet of gravel when dry..... = 1 ton.
25 cubic feet of sand..... = 1 ton.
18 cubic feet of earth in bank..... = 1 ton.
27 cubic feet of earth when dry..... = 1 ton.
17 cubic feet of clay..... = 1 ton.

Prospector's Gold Table

FOR DETERMINING THE VALUE OF FREE GOLD PER TON (2,000 LBS.) OF QUARTZ OR CUBIC YARD OF GRAVEL.

The table below furnishes an exceedingly simple method of determining the value of Free Gold in a ton of gold-bearing quartz, or a cubic yard of auriferous gravel.

Take a sample of four (4) pounds of quartz, pulverize it to the usual fineness for horning; wash it carefully by batea, pan, or other means; amalgamate the gold by the application of quicksilver; volatilize the quicksilver by blow-pipe or otherwise; weigh the resulting button, and the value given in the table opposite such weight will be the value in free gold per ton of 2,000 lbs. of quartz,

EXAMPLE.—Sample of four lbs. produces button weighing one grain, the fineness of the gold being 830; then the value of one ton of such quartz will be $17.87.

If the sample of four pounds should produce a button weighing, say four-tenths of a grain (.4), then the value of such quartz would be (830 fine) $7.14 per ton.

Weight washed gold. 4 lb. sample. Grains.	Fineness, 780. Value per oz. $16.12.	Fineness, 830. Value per oz. $17.15.	Fineness, 875. Value per oz. $18.08.	Fineness, 920. Value per oz. $19.01.
.1	$ 1.68	$ 1.78	$ 1.88	$ 1.98
.2	3.36	3.57	3.76	3.96
.3	5.03	5.36	5.65	5.94
.4	6.71	7.14	7.53	7.92
.5	8.40	8.93	9.42	9.90
.6	10.07	10.73	11.30	11.88
.7	11.75	12.51	13.19	13.86
.8	13.43	14.29	15.07	15.84
.9	15.11	16.08	16.95	17.82
1	16.79	17.87	18.84	19.81
2	33.59	35.74	37.68	39.62
3	50.38	53.61	56.52	59.43
4	67.18	71.49	75.36	79.24
5	83.97	89.36	94.20	99.05

Prospector's Gold Table.

(CONTINUED.)

GOLD VALUE OF A CUBIC YARD OF GRAVEL.

To determine the gold value of a cubic yard of auriferous gravel, the same table can also be used.

Take a sample of sixty (60) pounds of gravel, pulverize it, and carefully wash it by batea, pan or otherwise; amalgamate the gold, volatilize the quicksilver; weigh the button, and in column in table, opposite the weight, will be found the gold value of the cubic yard of gravel.

EXAMPLE.—Sample of sixty pounds produces button weighing one grain, the fineness of the gold being 780; then the value of one cubic yard of such gravel would be $1.67. This is arrived at by pointing off one point, or dividing the value given in table by 10.

If the sample of sixty pounds yields a button weighing five-tenths (.5) of a grain, then the value of the gravel would be—gold being 780 fine—$0.84 per cubic yard.

SIMPLE ORE TESTS.

The following simple tests will show whether an ore carries any precious metals. Afterwards samples of the rock should be assayed to ascertain the amount of value per ton:

Gold—Powder; roast if sulphurets are present; grind very fine and wash in pan or spoon; examine with lens; yellow particles not soluble in nitric acid. The color of pure gold is bright yellow, tinged with red. Gold may be distinguished from all other metals or alloys by the following simple traits: It is yellow, malleable, not acted upon by nitric acid.

Silver.—Pure silver is the brightest of metals, of a beautiful white color and rich luster.

Chloride of Silver.—If suspected in a pulp, harshly rub a bright and wet copper cartridge thereon. If a chloride or chloride-bromide of silver, it will whiten the copper. Graphite will thus whiten copper or gold, but can be rubbed off.

Copper.—After roasting the pulp, intimately mix and well knead with a like quantity of salt and candle grease or any other fat, and cast into the fire, when the characteristic colors—first blue, then green—will appear. This test is better made at night.

Galena.—Black zinc blend is often mistaken for galena. The two may be distinguished by the infallible sign: The powder of galena is black; that of blende, brown or yellow.

Workshop Recipes.

Specially Useful to Engineers in the Mining Districts.

CEMENT FOR CAST IRON.

Two ounces sal ammoniac, one ounce sulphur and sixteen ounces of borings or filings of cast iron, to be mixed well in a mortar and kept dry. When required for use, take one part of this powder to twenty parts of clear iron borings or filings, mix thoroughly in a mortar; make the mixture into a stiff paste with a little water, and then it is ready for use. A little fine grindstone sand improves the cement.

RED LEAD CEMENT FOR FACE JOINTS.

Equal parts of white and red lead mixed with linseed oil to the consistency.

CEMENT—STEAM BOILER.

Litharge in fine powder two parts, very fine sand and quicklime (that has been allowed to slack spontaneously in a damp place), of each one part; mix, and keep it from the air.

Used to mend cracks in boilers and to secure steam joints.

It is made into a paste with boiled oil before application.

CEMENT—STEAM PIPE.

Good linseed-oil varnish is ground with equal weights of white lead, oxide of manganese and pipe clay.

CEMENT—HYDRAULIC.

Made by slaking lime with water containing about two per cent of gypsum and adding a little sand to the product.

The presence of the gypsum tends to delay the slaking of the lime, and also to harden the substance formed after the slaking.

CEMENT—CUTLERS'.

Black resin four parts, beeswax one part, finely powdered brickdust one part; mix well.

Used to fix tools into their handles.

CEMENT—LEATHER.

Gutta-percha one pound, caoutchouc four ounces, pitch two ounces, shellac one ounce, linseed oil two ounces, melted together; must be melted before being applied.

Used for uniting leather or rubber.

SOLDERS.

For Lead, one of tin and one and one-half of lead.

For Tin, one of tin and two of lead.

For Pewter, two of tin and one of lead.

For Brazing (hardest), three of copper and one of zinc.

For Brazing (hard), one of copper and one of zinc.

For Brazing (soft), one of tin, four of copper and three of zinc; or two of tin and one of antimony.

FLUXES FOR SOLDERING OR WELDING.

For Iron or Steel, borax or sal ammoniac.
For Tinned Iron, resin or chloride of zinc.
For Copper and Brass, sal ammoniac or chloride of zinc.
For Zinc, chloride of zinc.
For Lead, tallow or resin.
For Lead and Tin Pipes, resin and sweet oil.

BRAZING.

The edges filed or scraped clean and bright, covered with spelter and powdered borax, and exposed in a clear fire to a heat sufficient to melt the solder.

CASE HARDENING WITH PRUSSIATE OF POTASH.

Heat the articles, after polishing, to a bright red, rub the surface over with prussiate of potash, allow it to cool to a dull red, and immerse it in water.

CASE HARDENING MIXTURES.

Three parts of prussiate of potash to one part of sal ammoniac, mixed; or two parts of sal ammoniac, two parts of bone dust, and one part of prussiate of potash.

MIXTURE FOR WELDING STEEL.

One part of sal ammoniac and ten parts of borax pounded together and fused until clear, when it is poured out, and when cool reduced to powder.

TEMPERING STEEL.

Steel in its hardest state being too brittle for most purposes, the requisite strength and elasticity are obtained by tempering—or *letting down the temper,* as it is termed—which is performed by heating the hardened steel to a certain degree and cooling it quickly. The requisite heat is usually ascertained by the color which the surface of the steel assumes from the film of oxide thus formed. The degrees of heat to which these several colors correspond are as follows:

At 430, a very faint yellow. At 450, a pale straw color.
Suitable for hard instruments; as hammer faces, drills, etc.

At 470, a full yellow. At 490, a brown color.
For instruments requiring hard edges without elasticity; as shears, scissors, turning tools, etc.

At 510, brown, with purple spots. At 538, purple.
For tools, for cutting wood and soft metals; such as plane-irons, knives, etc.

At 550, dark blue. At 560, full blue.
For tools requiring strong edges without extreme hardness; as cold chisels, axes, cutlery, etc.

At 600, grayish blue, verging on black.
For spring temper, which will bend before breaking; as saws, sword blades, etc.

If the steel is heated higher than this, the effect of the hardening process is destroyed.

Various Measures.

MEASURE OF SURFACE.

144 square inches ..... =1 square foot.
9 square feet ..... =1 square yard.
30.25 square yards ..... =1 square rod.
160 square rods ..... =10 square chains=43,560 square feet=1 acre.
640 acres ..... =1 square mile.

MEASURE OF VOLUME.

1,728 cubic inches ..... =1 cubic foot.
27 cubic feet ..... =1 cubic yard.

MEASURE OF WEIGHT.

Avordupois.

16 drams ..... =1 ounce.
16 ounces ..... =1 pound.
112 pounds ..... =1 cwt.
20 cwt ..... =1 ton.

Troy.

24 grains ..... =1 dwt.
20 dwts ..... =1 ounce.
12 ounces ..... =1 pound.
1 Troy pound ..... =.822857 lb. Avordupois.

To reduce Avordupois pounds to Troy ounces, multiply the Avordupois pounds by 14.5833.

Water.

A gallon of water (U. S. Standard) weighs $8\frac{1}{3}$ pounds, and contains 231 cubic inches.

A cubic foot of water weighs 62½ pounds, and contains 1,728 cubic inches, or 7½ gallons.

MEASURE OF LENGTH.

1 meter ..... =3.2808 feet.
1 chain ..... =100 links=4 rods=66 feet=7.92 inches.
80 chains ..... =1 mile=5,280 feet.
1 statute mile ..... =320 rods=1,760 yards=5,280 feet.
1 league ..... =3 nautical miles.
1 nautical knot ..... =6,086 feet longitude, 6,076.5 feet latitude.

A log-line is a knotted cord, the distance between the knots being $\frac{1}{120}$ of a nautical mile apart, that is, $50\frac{75}{120}$ feet. The log-line is allowed to run out for 30 seconds, which is $\frac{1}{120}$ of an hour, so that the distance between knots on the cord bears the same ratio to a degree that the time does to an hour.

Contents in Feet of Various Sizes of Timber and Lumber.

LENGTH IN FEET.

Width and thickness.	12	14	16	18	20	22	24	26	28	30
½ x 4	2	2.35	2.66	3.	3.35	3.66	4	4.33	4.66	5.
1 x 4	4	4.66	5.33	6.	6.66	7.33	8	8.66	9.33	10.
1 x 5	5	5.83	6.66	7.5	8.33	9.16	10	10.83	11.66	12.5
1 x 6	6	7.	8.	9.	10.	11.	12	13.	14.	15.
1 x 8	8	9.33	10.66	12.	13.33	14.66	16	17.33	18.66	20.
1 x 10	10	11.66	13.33	15.	16.66	18.33	20	21.66	23.33	25.
1 x 12	12	14.	16.	18.	20.	22.	24	26.	28.	30.

Width and thickness.	12	14	16	18	20	22	24	26	28	30
2 x 4	8	9	11	12	13	15	16	17	19	20
2 x 6	12	14	16	18	20	22	24	26	28	30
2 x 8	16	19	21	24	27	29	32	35	37	40
2 x 10	20	23	27	30	33	37	40	43	47	50
2 x 12	24	28	32	36	40	44	48	52	56	60
2 x 14	28	33	37	42	47	51	56	61	65	70
3 x 8	24	28	32	36	40	44	48	52	56	60
3 x 10	30	35	40	45	50	55	60	65	70	75
3 x 12	36	42	48	54	60	66	72	78	84	90
3 x 14	42	49	56	63	70	77	84	91	98	105
4 x 4	16	19	21	24	27	29	32	35	37	40
4 x 6	24	23	32	36	40	44	48	52	56	60
4 x 8	32	37	43	48	53	59	64	69	75	80
4 x 10	40	47	53	60	67	73	80	87	93	100
4 x 12	48	56	64	72	80	88	96	104	112	120
4 x 14	56	65	75	84	93	103	112	121	131	140
6 x 6	36	42	48	54	60	66	72	78	84	90
6 x 8	48	56	64	72	80	88	96	104	112	120
6 x 10	60	70	80	90	100	110	120	130	140	150
6 x 12	72	84	96	108	120	132	144	156	168	180
6 x 14	84	98	112	126	140	154	168	182	169	210
8 x 8	64	75	85	96	107	117	128	139	149	160
8 x 10	80	93	107	120	133	147	160	173	187	200
8 x 12	96	112	128	144	160	176	192	208	224	240
8 x 14	112	131	149	168	187	205	224	243	261	280
10 x 10	100	117	133	150	167	183	200	217	233	250
10 x 12	120	140	160	180	200	220	240	260	280	300
10 x 14	140	163	187	210	233	257	280	303	327	350
12 x 12	144	168	192	216	240	264	288	312	336	360
12 x 14	168	196	224	252	280	308	336	364	392	420
14 x 14	196	229	261	294	327	359	392	425	457	490

Concrete.

To make concrete for machinery foundations or retaining walls, use one yard of broken rock small enough to go through a three-inch mesh screen, one-half yard of sand and one barrel of Portland cement; thoroughly mix together when dry. Do not add any water until it is required for use, then add enough water to make a thick mortar; mix in small quantities and use at once; thoroughly tamp with a suitable tamping bar, immediately.

Concrete will set enough in twenty-four hours to carry a load, and in three to four days will be hard enough to run machinery on.

Should broken rock be difficult to obtain, use clean creek gravel of about the same size, instead.

In no case use loam, clay or very fine sand.

For special strength, more cement may be used.

For rubble masonry use five yards of stone, one yard of sand and one barrel of lime. One and one-third yards of stone required for one yard of masonry.

For boiler walls use per 1,000 bricks, one yard of sand and one barrel of lime.

Fifty pounds of fire-clay required to lay one hundred bricks.

Average Weight of Earths, Rocks, etc.,

PER CUBIC YARD.

Sand	3,360 lbs.	Sandstone	4,368 lbs.
Gravel	3,360 "	Shale	4,480 "
Mud	2,800 "	Quartz	4,492 "
Marl	2,912 "	Granite	4,700 "
Clay	3,472 "	Trap	4,700 "
Chalk	4,032 "	Slate	4,710 "

Transmission of Power by Belts.

The resistance of belts to slipping is independent of their breadth, consequently there is no advantage derived in increasing this dimension beyond that which is necessary to enable the belt to resist the strain it is subject to.

The ratio of friction to pressure for belts over wood drums is: For leather belts, when worn, .47; when new, .5; and, when over a turned cast-iron pulley, .24 and .27.

A leather belt will safely and continuously resist a strain of 350 pounds per square inch of section, and a section of .2 of a square inch will transmit the equivalent of a horse-power at a velocity of 1,000 feet per minute over a wooden drum, and .4 of a square inch over a turned cast-iron pulley.

In high-speed belting the tension or the breadth of the belt should be increased in order to prevent belt from slipping. Long belts are more effective than short ones.

A single belt one inch wide, traveling at a velocity of 1,000 feet per minute, transmits one horse-power.

A double belt one inch wide, traveling 700 feet per minute, transmits one horse-power.

When a double belt is long and runs over large pulleys, it may be calculated to do one horse-power of work at a speed of 500 feet per minute.

The upper side of the pulley should always carry the slack belt.

To throw a belt onto its pulleys, when it has been laid off, it should always be laid onto the pulley that is not in motion first, and then be thrown over the edge of the moving pulley onto its face.

It has been ascertained by trial that a belt will transmit about 30 per cent more power, with a given tension, when the grain (smooth side of the leather) is in contact with the pulley than when the flesh side is turned inward. The leather is also less liable to crack, as the structure on the flesh side is less dense, and the fibers more yielding. The adhesion of belts is greater on polished than on rough pulleys, and is about 50 per cent greater on a leather covered pulley than on a polished iron pulley. Large pulleys and drums may be covered with narrow strips of leather or with longer strips wound spirally. Pulley covers are manufactured in strips of the desired width, and reduced to uniform thickness by machinery. Belts should be kept soft and pliable by applying tallow occasionally and neat's-foot or liver oil, with a little resin when they become hard and dried.

Rubber belts ought always to be kept bree from grease or animal oils. If they slip, moisten the inside of the belt with boiled linseed oil. Some fine chalk sprinkled on over the oil will help the belt.

RULE FOR FINDING THE LENGTH OF BELTS.

Add the diameter of the two pulleys together, multiply by $3\frac{1}{8}$, divide the product by two, add to the quotient twice the distance between the center of the shafts, and the product will be the required length.

RULE FOR CALCULATING THE POWER OF BELTING.

One-inch single belt, moving at a velocity of 1,000 feet per minute, equals one horse-power.

One-inch double belt, moving 700 feet per minute, equals one horse-power.

Horse-power of any belt equals its velocity in feet per minute multiplied by its width and divided by 1,000 for single and by 700 for double belts.

RULES FOR CALCULATING THE SPEED OF PULLEYS.

The diameter of the driven being given to find its number of revolutions:

Rule: Multiply the diameter of the driver by the number of its revolutions, and divide the product by the diameter of the driven. The quotient will be the number of revolutions of the driven.

To find the diameter of the driven that shall make a required number of revolutions, the diameter and speed of the driver being given:

Rule: Multiply the diameter of the driver by its number of revolutions and divide the product by the number of revolutions of the driven. The quotient will be the diameter.

To find the diameter of the driver, its speed and the diameter and revolutions of the driven being given:

Rule: Multiply the diameter of the driven by its number of revolutions and divide the product by the revolutions of the driver. The quotient will be the diameter of the driver.

PRICE LIST OF STANDARD BELTING.

Inch.	Rubber.					Leather.	
	2-ply. Per foot.	3-ply. Per foot.	4-ply. Per foot.	5-ply. Per foot.	6-ply. Per foot.	Single.	Double
1	$0.07	....	....	....	....	$0.12	$0.24
1¼	.09	....	....	....	....	.16	.32
1½	.11	....	....	....	....	.20	.40
2	.15	$0.17	$0.21	$0.26	$0.31	.28	.56
2½	.18	.22	.26	.33	.39	.36	.72
3	.22	.26	.31	.39	.47	.44	.88
3½	.26	.30	.37	.46	.56	.52	1.04
4	.30	.34	.42	.53	.63	.60	1.20
4½	.33	.39	.47	.59	.71	.68	1.36
5	.36	.43	.52	.65	.78	.76	1.52
6	.43	.52	.62	.78	.93	.92	1.84
7	.51	.60	.73	.91	1.10	1.08	2.16
8	.59	.70	.84	1.05	1.26	1.24	2.48
9	.67	.80	.95	1.18	1.42	1.40	2.80
10	.75	.90	1.07	1.33	1.60	1.56	3.12
11	.83	1.00	1.18	1.47	1.77	1.72	3.44
12	.91	1.08	1.30	1.62	1.95	1.88	3.76
13	1.00	1.18	1.42	1.77	2.13	2.04	4.08
14	1.08	1.28	1.54	1.92	2.31	2.20	4.40
15	1.16	1.38	1.66	2.07	2 49	2.40	4.80
16	1.25	1.50	1.78	2.22	2.67	2.60	5.20
18	1.41	1.70	2.02	2.52	3.03	3.00	6.00
20	1.58	1.90	2.26	2.82	3.39	3 40	6.80
22	1.76	2.12	2.52	3.15	3.78	3.80	7.60
24	1.96	2.36	2.80	3.50	4.20	4.20	8.40
26	2.18	2.60	3.08	3.85	4.62	4.60	9.20
28	2.42	2.84	3.36	4.20	5.04	5.00	10.00
30	....	....	3.64	4.55	5.46	5.50	11.00
32	....	....	3.92	4.90	5.88	6.00	12.00
34	....	....	4.20	5.25	6.30	6.50	13.00
36	....	....	4.48	5.60	6.72	7.00	14.00
38	....	....	4.76	5.95	7.14	....	.....
40	....	....	5.04	6.30	7.56	7.80	15.60
42	....	....	5.32	6.65	7.98	8.20	16.40
44	....	....	5.60	7.00	8.40	8.60	17.20
46	....	...	5.88	7.35	8.82	9.00	18.00
48	....	....	6.16	7.70	9.24	9.40	19.80
50	....	....	6.44	8.05	9.66	....	.....
52	....	....	6.72	8.40	10.08	....	.....
54	....	....	7.00	8.75	10.50	....	.....
56	....	.. .	7.28	9.10	10.92	....	.....
58	....	....	7.56	9.45	11.34	....	.....
60	....	....	7.84	9.80	11.76	....	.....

PRICE LIST OF STANDARD WATER HOSE.

Interior Diameter.	2-ply. Per foot.	3-ply. Per foot.	4-ply. Per foot.	Brass Couplings, each.
½ inch	$0.20	$0.25	$0.30	$0.20
¾ "	.25	.30	.37	.20
1 "	.33	.40	.50	.40
1¼ "	.42	.50	.62	.85
1½ "	.50	.60	.75	1.15
1¾ "	.58	.70	.87	....
2 "	.66	.80	1.00	2.00
2¼ "	.75	.90	1.12	....
2½ "	.83	1.00	1.25	4.00
2¾ "	.92	1.10	1.37	....
3 "	.99	1.20	1.50	6.35
3½ "	1.15	1.40	1.75	....
4 "	1.32	1.60	2.00	....
5 "	1.65	2.00	2.50	....
6 "	1.98	....	....	....
7 "	2.31	....	....	....
8 "	2.64	....	....	....
9 "	2.97	....	....	....
10 "	3.33	....	....	....

Water Hose.

Conducting Hose, Two-ply.—Designed to conduct water under moderate pressure only. Sizes above three-inch are mainly for tank hose.

Hydrant Hose, Three-ply.—Of medium strength, suitable for hydrants, garden and pump uses, street sprinkling, washing decks, etc.

Engine Hose, Four-ply.—Recommended for all purposes where a particularly strong and reliable article is required, and is made to stand a pressure of from 100 to 200 pounds per square inch.

Five-ply and Six-ply Hose.—For use where great resistance to pressure, or very severe service, is demanded.

TABLE OF PRESSURES PER SQUARE INCH AT DIFFERENT ELEVATIONS OF RESERVOIR.

Elevation.	Pressure.	Elevation.	Pressure.
50 feet.	22 pounds.	150 feet.	65 pounds.
75 "	33 "	200 "	86 "
100 "	43 "	250 "	108 "
125 "	54 "	300 "	130 "

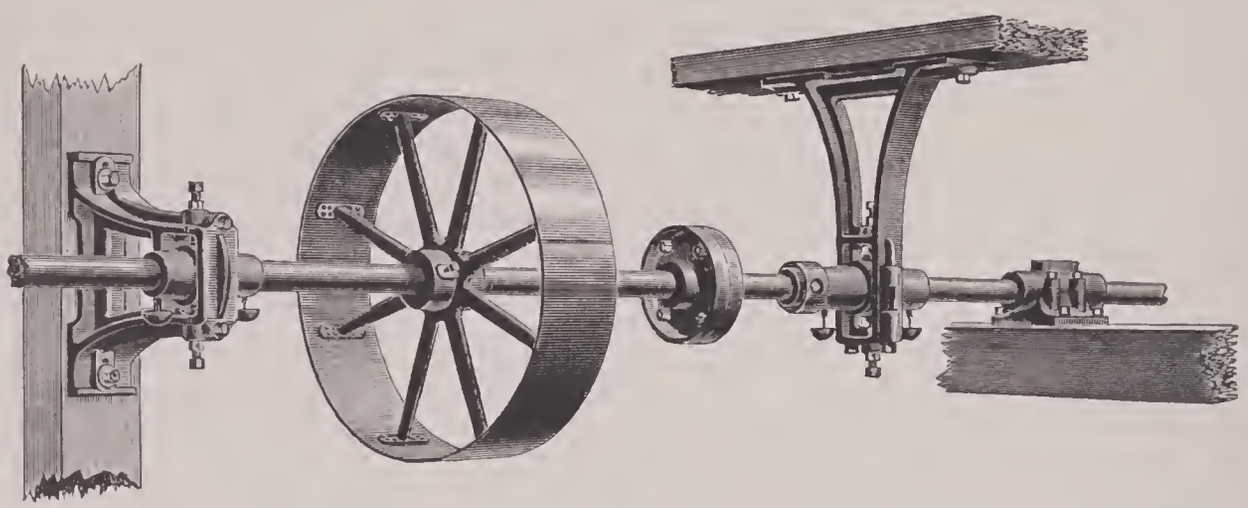
Dealers and consumers in different localities should consult and be guided by this table in ordering hose, and thereby avoid dissatisfaction through the use of hose too light for the service.

Table Showing Gallons of Water Discharged

IN FIRE STREAMS THROUGH 100 FEET OF 2½-INCH RUBBER HOSE, WITH GIVEN NOZZLES (SMOOTH).

Diameter of nozzle.	Pressure at nozzle.	Gallons per minute.	Horizontal stream.	Vertical stream.	Diameter of nozzle.	Pressure at nozzle.	Gallons per minute.	Horizontal stream.	Vertical stream.
1	30	134	90	62	1⅛	70	259	163	125
1	40	155	109	76	1⅛	80	277	175	137
1	50	173	126	94	1⅛	90	294	186	148
1	60	189	142	108	1⅛	100	310	193	157
1	70	205	156	121	1¼	30	210	96	63
1	80	219	168	131	1¼	40	242	118	82
1	90	232	178	140	1¼	50	271	138	99
1	100	245	186	148	1¼	60	297	156	115
1⅛	30	170	93	63	1¼	70	320	172	129
1⅛	40	196	113	81	1¼	80	342	186	142
1⅛	50	219	132	97	1¼	90	363	198	154
1⅛	60	240	148	112	1¼	100	383	207	164

The loss by friction in 2½ rubber hose, throwing a 1-inch stream 100 feet high, is 15 pounds for each 100 feet of hose.



Shafting, Couplings, Hangers, Boxes and Collars.

TABLES OF SIZES AND PRICES.

SHAFTING. Turned, Cold Rolled and Polished.		COLLARS with Set Screws.	COUPLINGS. Finished and fitted to Shaft.		JOURNAL BOXES.	RIGID POST BOXES.	ADJUSTABLE POST HANGER.
Diameter of Shaft.	Price per foot.		Flange.	Clamp.	Babbitted.	Babbitted.	Babbitted.
1 3/16	$ .45	$ .50	$ 5.50	$ 4.00	$ 1.80	$ 3.00	.....
1 7/16	.51	.65	6.17	4.32	1.90	3.00	.....
1 11/16	.70	.80	6.38	4.88	2.15	3.60	.....
1 15/16	.93	1.00	7.65	6.19	2.90	4.00	$ 5.10
2 3/16	1.06	1.35	8.93	7.50	3.50	4.75	6.38
2 7/16	1.32	1.50	10.63	9.00	4.25	5.50	7.45
2 11/16	1.60	1.70	13.18	11.07	5.15	6.50	9.35
2 15/16	2.03	1.90	15.73	13.13	6.25	7.25	11.25
3 3/16	2.41	2.10	18.70	15.38	6.75	9.00	.....
3 7/16	2.81	2.35	21.25	18.00	9.15	11.00	.....
3 11/16	3.45	2.55	24.30	22.00	10.90	13.00	.....
3 15/16	3.69	2.80	27.63	24.00	11.65	13.00	.....
4 7/16	4.50	3.50	33.25	33.00	15.56	17.00	.....

HANGERS—DOUBLE BRACED ADJUSTABLE PIVOTED BOXES.

Diam. of Shaft.	1 7/16	1 11/16	1 15/16	2 3/16	2 7/16	2 11/16	2 15/16	3 3/16	3 7/16	3 15/16	4 7/16
12 in.	$3.62	$4.05	$5.10	$6.38	$7.45	$9.35	.....	.....	.....	.....	.....
14 "	3.91	4.33	5.39	6.66	7.87	9.92	$11.90	.....	.....	.....	.....
16 "	4.11	4.55	5.67	6.95	8.30	10.35	12.33	.....	.....	.....	.....
18 "	4.25	4.68	5.95	7.32	8.72	10.63	12.75	$14.88	$19.13	$22.95	.....
20 "	....	....	6.24	7.51	9.15	11.05	13.13	15.45	19.70	23.52	.....
24 "	....	....	6.80	8.30	10.20	12.55	14.67	17.00	21.90	25.93	.....
26 "	....	....	8.10	10.00	11.80	13.40	16.05	.....	.....	.....	.....

Price List of Pulleys.

THIS LIST ADOPTED MARCH 1, 1897. THIS SUPERSEDES ALL FORMER LISTS.

Diam. Inches.	Face 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Diam. Inches.
4	1 90	2 00	2 10	2 20	2 40	2 60	2 85	3 10	3 35	3 60	3 85	4 10	4 40	4 75	5 10	....	....	....	.. .	. .	. ...	... .	.....	. ...	4
6	2 10	2 20	2 35	2 55	2 75	3 00	3 25	3 50	3 75	4 00	4 30	4 65	5 00	5 35	5 70	....	....	....	....	... .	.....	.....	.....	.....	6
8	2 35	2 45	2 60	2 80	3 00	3 25	3 50	3 75	4 00	4 30	4 65	5 00	5 40	5 80	6 20	....	....	....	....	.....	.....	.....	.....	.....	8
10	.. .	2 80	3 00	3 25	3 50	3 75	4 00	4 30	4 65	5 00	5 40	5 80	6 20	6 60	7 00	7 50	8 00	8 60	9 20	.....	. ...	.....	.....	.....	10
12	....	3 15	3 40	3 65	3 90	4 20	4 55	4 90	5 30	5 70	6 10	6 50	6 90	7 40	7 90	8 50	9 10	9 70	10 40	11 10	11 80	12 60	13 40	.....	12
14	....	3 45	3 70	4 00	4 35	4 70	5 10	5 55	6 00	6 45	6 90	7 40	7 90	8 50	9 10	9 70	10 40	11 10	11 80	12 60	13 40	14 20	15 00	.....	14
16	....	3 80	4 15	4 50	5 00	5 50	6 00	6 50	7 00	7 50	8 00	8 50	9 00	9 60	10 30	11 00	11 80	12 60	13 40	14 20	15 10	16 00	16 90	17 80	16
18	....	4 20	4 70	5 20	5 70	6 20	6 70	7 20	7 80	8 40	9 00	9 60	10 30	11 10	11 90	12 70	13 50	14 30	15 20	16 10	17 00	17 90	19 00	20 10	18
20	....	4 60	5 20	5 80	6 40	7 00	7 60	8 30	9 00	9 70	10 40	11 20	12 00	12 90	13 80	14 70	15 60	16 50	17 50	18 50	19 60	20 70	21 80	22 90	20
22	....	5 00	5 60	6 30	7 00	7 70	8 40	9 20	10 00	10 80	11 70	12 60	13 50	14 50	15 50	16 60	17 70	18 80	20 00	21 20	22 40	23 60	24 80	26 00	22
24	....	5 50	6 20	7 00	7 80	8 60	9 40	10 30	11 20	12 10	13 00	14 10	15 30	16 50	17 70	18 90	20 20	21 50	22 80	24 10	25 40	26 80	28 20	29 60	24
26	....	6 20	7 00	7 80	8 60	9 50	10 50	11 50	12 60	13 75	15 00	16 30	17 60	19 00	20 40	21 80	23 30	24 80	26 30	27 90	29 50	31 10	32 70	34 30	26
28	....	7 00	7 80	8 60	9 50	10 50	11 60	12 80	14 00	15 20	16 50	17 90	19 40	20 90	22 40	24 00	25 60	27 20	28 80	30 40	32 00	33 60	35 30	37 00	28
30	....	7 70	8 60	9 50	10 60	11 80	13 00	14 30	15 60	17 00	18 50	20 00	21 50	23 25	25 00	26 75	28 50	30 25	32 00	33 75	35 50	37 25	39 00	40 75	30
32	....	8 50	9 50	10 50	11 60	12 85	14 10	15 50	17 00	18 60	20 30	22 00	23 80	25 60	27 40	29 20	31 00	33 00	35 00	37 00	39 00	41 00	43 00	45 00	32
34	....	9 40	10 60	11 80	13 10	14 45	15 90	17 40	19 00	20 70	22 50	24 20	26 10	27 90	29 80	31 70	33 60	35 70	37 80	40 00	42 20	44 40	46 80	49 20	34
36	....	10 30	11 70	13 10	14 60	16 10	17 70	19 30	21 00	22 00	24 00	26 00	28 00	30 00	32 00	34 00	36 00	38 00	40 00	43 00	45 00	47 00	50 00	53 00	36
38	....	....	12 80	14 40	16 00	17 70	19 50	21 20	23 00	24 50	26 00	28 00	30 00	32 00	34 00	36 00	38 00	41 00	43 00	46 00	48 00	51 00	54 00	57 00	38
40	....	....	13 90	15 70	17 50	19 30	21 25	23 10	25 00	26 50	28 00	30 00	32 00	34 00	36 00	39 00	41 00	43 00	46 00	49 00	51 00	54 00	58 00	61 00	40
42	....	....	15 00	17 00	19 00	21 00	23 00	25 00	27 00	29 00	31 00	33 00	35 00	37 00	39 00	41 00	44 00	46 00	49 00	52 00	55 00	58 00	62 00	66 00	42
44	....	....	17 00	19 00	21 00	23 00	25 00	27 00	29 00	31 00	33 00	35 00	37 00	40 00	42 00	44 00	47 00	50 00	53 00	56 00	60 00	63 00	67 00	71 00	44
46	....	....	19 00	21 00	23 00	25 00	27 00	29 00	31 00	33 00	36 00	38 00	40 00	43 00	45 00	48 00	51 00	54 00	57 00	61 00	65 00	68 00	73 00	77 00	46
48	....	....	21 00	23 00	25 00	27 00	29 00	31 50	33 90	36 20	38 50	40 00	43 00	46 00	48 00	51 00	54 00	58 00	61 00	65 00	70 00	74 00	78 00	83 00	48
50	....	....	...	25 00	27 00	29 00	31 00	33 70	36 20	38 60	41 00	43 00	46 00	49 00	51 00	54 00	58 00	62 00	65 00	70 00	75 00	79 00	84 00	89 00	50
52	. .	....	.. .	28 00	30 00	32 00	34 00	36 00	38 50	41 00	43 50	46 00	49 00	52 00	55 00	58 00	62 00	66 00	70 00	75 00	80 00	85 00	90 00	95 00	52
54	...	....	....	30 00	32 00	34 00	36 00	38 50	41 20	43 80	46 00	49 00	52 00	55 00	59 00	62 00	66 00	70 00	75 00	80 00	85 00	90 00	95 00	100 00	54
56	....	....	....	.....	35 00	37 00	39 00	41 00	43 00	46 00	49 00	52 00	55 00	59 00	63 00	66 00	71 00	75 00	80 00	85 00	90 00	95 00	101 00	106 00	56
58	....	....	....	.....	38 00	40 00	42 00	44 00	46 00	49 00	52 00	55 00	59 00	62 00	67 00	71 00	75 00	80 00	85 00	90 00	95 00	101 00	106 00	112 00	58
60	....	....	....	.....	41 00	43 00	45 00	47 00	49 00	52 00	55 00	58 00	62 00	66 00	71 00	75 00	80 00	85 00	90 00	95 00	100 00	106 00	112 00	118 00	60
62	....	....	....	.....	44 00	46 00	48 00	50 00	52 00	55 00	58 00	62 00	66 00	70 00	75 00	80 00	85 00	90 00	95 00	100 00	106 00	112 00	118 00	124 00	62
64	....	...	....	.....	46 00	48 00	50 00	52 00	55 00	58 00	61 00	65 00	69 00	74 00	79 00	84 00	89 00	94 00	99 00	104 00	110 00	117 00	123 00	130 00	64
66	. .	....	....	. ...	48 00	50 00	52 00	54 00	57 00	61 00	64 00	69 00	73 00	78 00	83 00	88 00	93 00	98 00	103 00	109 00	115 00	122 00	129 00	136 00	66
68		....	....	.....	50 00	52 00	54 00	56 00	60 00	64 00	68 00	72 00	77 00	82 00	87 00	92 00	97 00	102 00	108 00	113 00	120 00	127 00	134 00	142 00	68
70		....	...	. ...	52 00	54 00	56 00	59 00	63 00	67 00	71 00	76 00	81 00	86 00	91 00	96 00	101 00	106 00	112 00	118 00	125 00	132 00	140 00	148 00	70
72		...	....	. ..	54 00	56 00	58 00	62 00	66 00	70 00	75 00	80 00	85 00	90 00	95 00	100 00	105 00	111 00	117 00	123 00	130 00	138 00	146 00	155 00	72
78		....	....	.....	. ...	.....	71 00	75 00	80 00	85 00	90 00	95 00	100 00	105 00	110 00	116 00	121 00	127 00	133 00	140 00	147 00	155 00	164 00	173 00	78
84		...	..	. ...	.....	.....	85 00	90 00	96 00	101 00	107 00	112 00	118 00	123 00	130 00	136 00	143 00	149 00	156 00	163 00	170 00	179 00	188 00	197 00	84
90		....	....	.....	.....	.....	100 00	107 00	114 00	121 00	128 00	135 00	142 00	149 00	157 00	165 00	173 00	181 00	189 00	197 00	206 00	215 00	225 00	235 00	90
96		....	....	.....	.....	.....	115 00	123 00	132 00	140 00	149 00	157 00	166 00	174 00	184 00	193 00	203 00	212 00	222 00	231 00	241 00	251 00	262 00	272 00	96

The prices quoted above are for regular standard pulleys balanced and key-waved. Pulleys of wider face than 18 inches are provided with two sets of arms without extra charge. When pulleys 18 inches and under are ordered with two sets of arms, an extra charge will be made, as a single set of arms when made from our heavy patterns is amply strong for any ordinary work.

We also make split pulleys, for which add 20 per cent to the above list.

In ordering give diameter, width of face, size of bore, and state whether the face is to be crowning or flat.

Price List of Standard Steam, Gas, Water Pipe and Fittings.

Butt and Lap-Welded Pipe.														
Nominal inside diameter, inches.	Nominal weight per foot.	Price per foot. Plain.	Couplings.	Elbows.	Tees.	Reducers.	Bushings.	Plugs.	Caps.	Nipples.	Unions.	Flange Unions.	Globe Valves.	Service Cocks.
⅛	.24	$0.05½	$0.05	$0.04	$0.07	....	....	....	$0.03	$0.04	$0.18	....	$0.72	.....
¼	.42	.05½	.05	.04	.07	$0.04	$0.04	$0.02	.03	.04	.18	....	.72	$ .75
⅜	.56	.05½	.06	.06	.07	.06	.04	.02	.04	.04	.20	....	.77	.85
½	.84	.07	.07	.08	.10	.07	.04	.02	.05	.05	.22	$0.40	1.00	.95
¾	1.12	.08½	.10	.11	.13	.10	.05	.03	.08	.07	.27	.46	1.26	1.15
1	1.67	.11¾	.13	.15	.20	.14	.06	.01	.12	09	.33	.52	1.80	1.50
1¼	2.24	.15½	.17	.20	.23	.18	.07	.05	.16	.12	.46	.64	2.52	2.25
1½	2.68	.26	.21	.30	.34	.25	.09	.07	.21	.15	.58	78	3 50	3.10
2	3.61	.35	.28	.50	.52	.40	.14	.10	.32	.19	.75	1.00	5.30	5.00
2½	5.74	.52	.40	90	1.20	.70	.21	.18	.60	.38	1.55	1.25	10.00	11.00
3	7.54	.68	.60	1.40	1.80	1.00	.30	.25	.85	.50	2.10	1.50	14.40	16.00
3½	9 00	.81	.80	2.00	2.50	1.50	.40	.38	1.10	.68	3.65	1 80	26.50	.....
4	10.66	.95	1.00	2.50	3.40	1.85	.50	.42	1.60	.78	4.35	2 10	36.00	.....
4½	12.34	1.25	....	....	....	....	....	....	....	1.18	....	....	.....	.....
5	14.50	1.42	1.65	4.00	....	....	.93	.88	....	1.40	....	3.15	.....	.....
6	18.76	1.85	2.40	5.00	....	....	1.25	1.20	...	1.75	....	3 95	.....	.....
7	23.27	2.45	....	....	....	....	....	....	....	1.88	....	....	.....	.....
8	28.18	2.95	....	....	....	....	....	....	...	2.25	....	....	.....	.....
9	33.70	3 75	....	....	....	....	....	....	....	3.25	....	....	.....	....
10	40.00	4.75	....	....	....	....	....	....	....	4.00	....	....	.....	.....
11	45.00	6.00	....	....	....	....	....	....	....	5.00	....	....	.....	.....
12	49.00	7.00	....	....	....	....	....	....	....	6.00	....	....	....	.....
13	54 00	8.50	....	....	....	....	....	....	....	....	....	....	.....	.....
14	58.00	10.00	....	....	....	....	....	....	....	....	....	....	.....	.....
15	62.00	12 00	....	....	....	....	....	....	....	....	....	....	....	.....

Further prices furnished upon application.

Price List of Lap-welded Light Wrought-iron Pipe and Cast-iron Fittings,

SPECIALLY ADAPTED FOR

WATER PIPE, EXHAUST STEAM, PUMP DISCHARGE AND PUMP COLUMNS, COMPRESSED AIR AND REFRIGERATING PURPOSES, AND FOR MINING AND HYDRAULIC PURPOSES GENERALLY. WITH CAST-IRON FLANGES, SHRUNK ON.

Actual outside diameter, inches.	Nominal inside diameter, inches.	Thickness.		External diameter of flanges on pipe, inches.	Nominal weight per foot, pounds.	Price per foot, with cast-iron flanged ends.	Price, Each.						
		W. G.	Inches.				Elbows.	Tees.	Crosses.	Reducers.	Extra flanges.	Bolts and nuts.	Composition gaskets.
2	1.85	15	.072	4¾	1.69	$0.33	$0.85	$ 1.20	$1.40	$0.95	$0.14	$0.02½	$0.04
2½	2.33	14	.083	5¼	2.40	.45	1.00	1.40	1.60	1.10	.15	.02½	.05
3	2.82	13½	.089	5¾	3.12	.57	1.20	1.60	1.90	1.30	.17	.02½	.06
3½	3.31	13	.095	6½	3.90	.68	1.50	1.85	2.20	1.65	.19	.03	.08
4	3.79	12½	.102	7	4.75	.80	1.60	2.05	2.40	1.75	.21	.03	.10
4½	4.28	12	.109	7½	5.63	.95	1.80	2.40	2.90	1.95	.24	.03	.12
5	4.77	11½	.114	8½	6.52	1.05	2.10	2.75	3.30	2.30	.36	.03	.14
6	5.77	11½	.114	9⅝	8.07	1.30	2.40	3.60	3.85	2.65	.54	.03	.17
7	6.74	10½	.127	11	10.36	1.65	2.85	4.65	5.60	3.20	.60	.05	.20
8	7.74	10½	.127	12	11.72	1.90	4.20	6.50	7.75	4.60	.78	.05	.23
9	8.73	10	.134	13½	14.67	2.35	5.70	8 10	9.60	6.20	1.10	.05	.32
10	9.73	10	.134	15	16.00	2.75	7.25	10.00	12.00	8.00	1.40	.07	.40
11	10.70	9	.148	16	19.41	3.25	9.20	12.25	14.75	10.00	1.60	.08	.45
12	11.67	8	.165	17¼	24.00	3.75	10.75	16.75	18.25	11.80	1.75	.08	.72
13	12.65	7½	.173	18¼	27.90	4.30	12.60	18.25	21.50	13.80	1.95	.08	.80
14	13.62	7	.180	19¼	29.50	4.75	14.75	20.50	26.00	16.00	2.10	.08	.90
15	14.60	6½	.191	20½	34.50	5.30	18.60	25.00	30.00	20.40	2.30	.08	1.05
16	15.56	5	.220	21½	41 20	6.25	22.25	31.20	37.00	24.50	2.45	.08	1.25
17	16 52	4	.238	22¾	47.00	6.70	27 50	37.20	44.00	30.00	2.65	.10	1.40
18	17.48	3	.259	23¾	53.25	7.20	31.25	43.20	51.00	34 50	3.00	.10	1.70
19	18.45	2½	.272	24¾	58.75	8.30	36.00	49.00	59.00	39.60	3.40	.10	2 00
20	19.44	2	.284	25¾	65.50	9.50	41.00	55.00	65.00	45.00	3.90	.10	2.35

This pipe furnished in promiscuous lengths to twenty feet long, or to any specific lengths that may be required.

Prices on larger diameters, also pipe heavier than above standard gauges, furnished upon application.

The above pipe furnished *galvanized* or *tarred*, when necessary, *at additional charge*. Further prices furnished upon application.

Useful Information.

WATER.

Doubling the diameter of a pipe increases its capacity four times. Friction of liquids in pipes increases as the square of the velocity.

The mean pressure of the atmosphere is usually estimated at 14.7 pounds per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches or a column of water 33.9 feet high.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434. Approximately, we say that every foot of elevation is equal to ½-pound pressure per square inch; this allows for ordinary friction.

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the standard of speed), divide the number of gallons by 4; then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find quantity of water elevated in one minute running at 100 feet of piston speed per minute, square the diameter of the water cylinder in inches and multiply by 4. Example: Capacity of a 5-inch cylinder is desired. The square of the diameter (5 inches) is 25, which multiplied by 4 gives 100, the number of gallons per minute (approximately).

To find the horse-power necessary to elevate water to a given height, multiply the total weight of the water to be elevated in one minute in pounds by the height in feet, and divide the product by 33,000 (an allowance of 25 per cent should be added for water friction, and a further allowance of 25 per cent for loss in steam cylinder).

The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. *The area of the water piston*, multiplied by the pressure of water per square inch, gives the resistance. *A margin* must be made between the *power* and the *resistance* to *move* the pistons at the required speed—say from 20 to 40 per cent, according to speed and other conditions.

To find the capacity of a cylinder in gallons, multiply the area in inches by the length of stroke in inches, and result will give the total number of cubic inches. Divide this number by 231 (which is the cubical contents of a U. S. gallon in inches), and product is the capacity in gallons.

SIZES OF TANKS AND CONTENTS.

Diameter, feet.	Depth, feet.	Gallons.	Diameter, feet.	Depth, feet.	Gallons.
8	8	3,015	22	11	31,277
10	8	4,712	24	12	40,607
12	8	6,767	26	13	51,628
14	9	10,363	28	14	64,481
16	9	13,535	30	15	79,310
18	10	19,034	32	16	96,253
20	10	23,499	34	17	115,451

Primitive Arrastra.

List of English Catalogues

ISSUED BY

THE UNION IRON WORKS.

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No. 1. Steam Engines, Boilers and Hydraulic Machinery.

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Section No. 2, Hoisting Machinery.

Section No. 3, Pumping Machinery.

No. 3. Metallurgical and Mining Machinery (out of print).

No. 4. Union Improved Ore Concentrator.

No. 5. Gold Milling, Metallurgical and Mining Machinery.

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No. 7. Silver Milling Machinery.

No. 8. Coarse Concentration and Smelting.

No. 9. Cyanide Process.

LIST OF SPANISH CATALOGUES.

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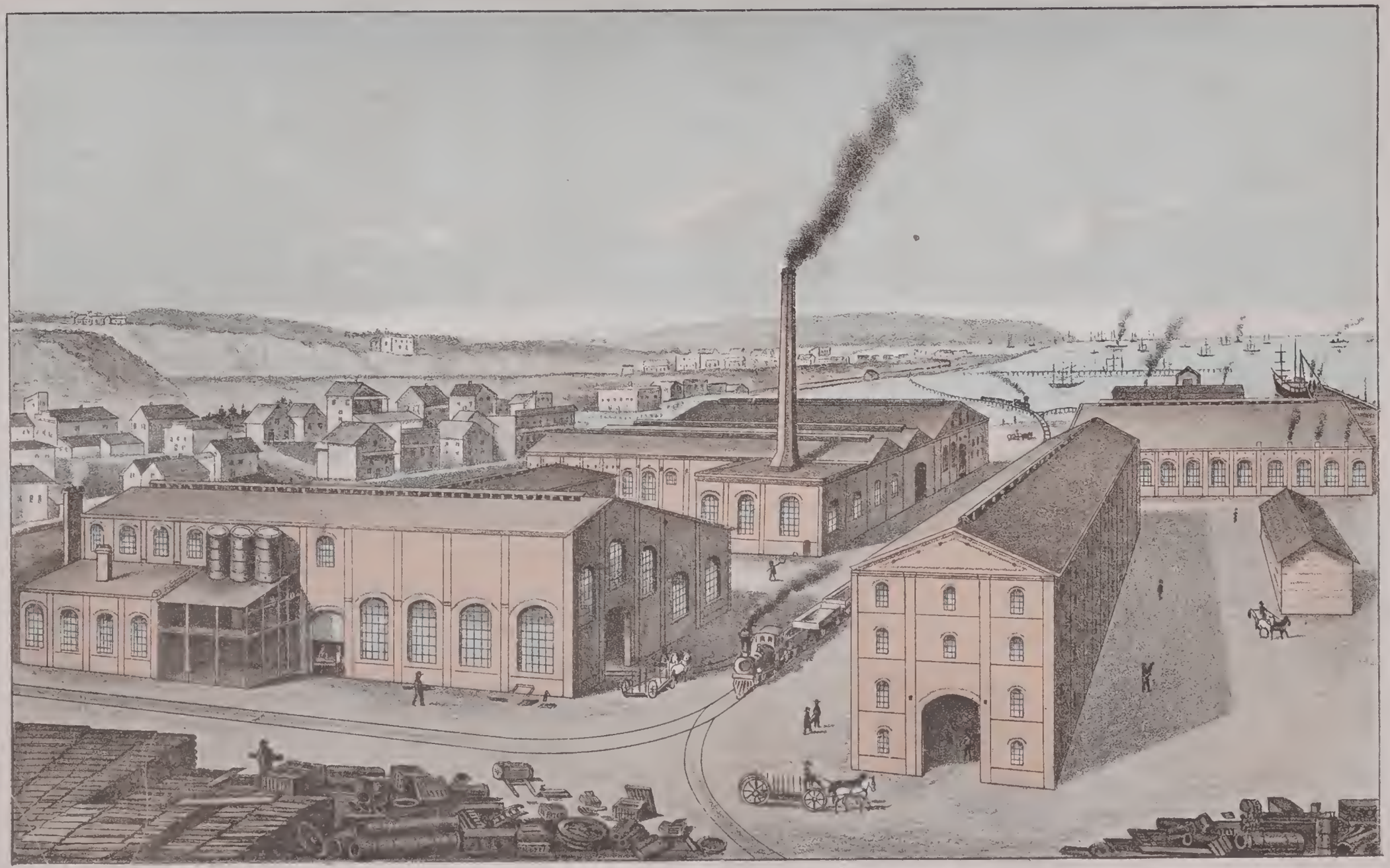

VIEW OF MACHINE SHOPS.